THURSDAY, SEPTEMBER 24, 1914.

SPECIALISED GEOLOGY.

(1) *Structural Geology.* By C. K. Leith. Pp. viii + 169. (London: Constable and Co., Ltd.) Price 6*s.* 6*d.* net.

(2) *Geologischer Führer durch Nordwest-Sachsen.* By E. Krenkel. Pp. vii + 202 + 14 plates. (Berlin: Gebrüder Borntraeger, 1914.) Price 4 marks.

(3) *Australasian Fossils. A Students' Manual of Palaeontology.* By F. Chapman. With an introduction by Prof. E. W. Skeats. Pp. 341. (Melbourne and London: G. Robertson and Co. Propy., Ltd., 1914.)

(4) *Practical Instructions in the Search for, and the Determination of, the Useful Minerals, including the Rare Ores.* By A. McLeod. Pp. ix + 114. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1914.) Price 5*s.* 6*d.* net.

(1) MR. LEITH'S book does not cover so wide a field as Prof. James Geikie's "Structural and Field Geology," which was reviewed in this journal in 1912 (vol. xc., p. 159), nor is it so attractive at first reading as Prof. Wilckens's "Grundzüge der tektonischen Geologie" (NATURE, vol. xcii., p. 564). But it represents the application of close thinking to the problems of earth-fracture and the displacement of rock-masses in regard to one another, and it forms a specialised manual for the student of all kinds of rock-flow. The large amount of sliding and differential movement that takes place between layers of the same contorted series may be well realised in the field; but it is not apparent in our ordinary diagrams. Mr. Leith, on p. 114 and elsewhere, very usefully directs attention to it, and connects the "drag-folds" seen on a small scale with the overfolded structure of the Alps. Willis's terms, "competent" and "incompetent," which are too familiar in their ordinary usage, are adopted (p. 111) for layers of rock that respectively resist and yield to compound crumpling. A fold may exhibit "competence" up to a certain point, and may become "incompetent" on continuance of pressure, yielding in this case as a series of folds in which the successive beds are similarly curved. The book is full of matter that leads to accurate realisation, and includes useful reviews of such widely separated terminals of the subject as the origin of joints and the theory of isostasy.

(2) In his description of North-west Saxony, Dr. E. Krenkel has the advantage of dealing with a district that includes a palæozoic range folded in Middle Carboniferous times, a conspicuous development of Permian strata with associated volcanic rocks, Oligocene and Miocene brown coals, and boulder-clay in which Scandinavian granite (rappakiwi) has been found. The combination is a happy one for those who study geology at Leipzig, though there is a large gap in the stratigraphical succession. The glacial and fluvioglacial deposits contain the mammoth, *Rhinoceros mercki*, and the reindeer. Ice-scratched surfaces are noted at several points, and the dry epoch at the close of the last ice-age has left its traces in the form of grooves etched by wind-borne sand on the porphyry cliffs of the Klein Berg (p. 91). The contact-metamorphism due to granite of Carboniferous age is studied in the last of the excursions, and the question is left open as to whether the associated gneisses are a marginal type of the granite, or an older mass into which the latter has intruded (p. 180).

(3) The early association of Mr. F. Chapman, now of the National Museum, Melbourne, with the detailed researches of Prof. Rupert Jones gave promise of the accurate contributions that he has made to Australian palæontology. It is an admirable sign of the times that Great Britain is no longer the field to which problems of the southern hemisphere must be referred. The publication of an introduction to the study of fossils in which Australian examples are primarily employed cannot fail to stimulate observation, and such absorbing details as the "Collyweston Slate" and the "Oldhaven Beds" may in time drop out of view in examination papers set for our antipodes. At the same time, the author will be the first to recognise that notable gaps in the record must be filled in by reference to other lands. The Triassic cephalopods and almost all fossil mammalia serve as notable examples, and a "students' manual of palæontology" may be expected to lay a broader foundation than is here given. Mr. Chapman's book, however, is justified by its principal title, and it will be of immense help to workers in Europe who require a ready reference to species recognised on the other side of the equator. The bibliographies following each chapter still further deserve our gratitude.

(4) Mr. McLeod's book is bound for the pocket, and contains useful hints for the prospector, who is shown how to perform a number of tests with ingenious and simple apparatus. It is, however, taken for granted that he will not be interested in the reactions involved. The chemical composition of minerals is loosely stated, and a mixed list of minerals and chemical oxides on p. 81 is styled a list of "ores." The mouth-blowpipe is not relied on; yet it would reduce cassiterite in

a tenth of the time occupied by the method given on p. 37, while a candle is often easier to deal with in experiments requiring heat than the "brisk wood fire" advocated on p. 23. We should like a prospector to take up this practical little book after an elementary course in mineralogy; but this seems too much to ask of those whose energy and observation may affect the fortunes of huge companies. G. A. J. C.

INSECTS AND DISEASE.

A Text-book of Medical Entomology. By Dr. W. S. Patton and Dr. F. W. Cragg. Pp. xxxiv+768+lxxxix plates. (London and Madras: The Christian Literature Society for India, 1913.) Price 15.12 rupees, or 1*l.* 1*s.*

THE vast literature which has sprung up in connection with medical entomology gives some indication of the importance of this comparatively new subject, and the work under review is the first attempt at a text-book. The subject chiefly concerns those medical and veterinary officers practising in the tropics, frequently out of the reach of current literature, and this book is designed to give to these men a concise introduction to entomology in so far as it is connected with medicine.

The book is divided into twelve chapters, and of these the first four, occupying rather more than half the volume, deal with flies. The blood-sucking and other noxious types of these insects are dealt with very fully, and chapter ii., which is entitled "Anatomy and Physiology of the Blood-sucking Diptera," is perhaps the best in the book. The different types of "biting" flies are discussed as to general structure and internal anatomy, and the question of the origin of the mouth-parts of the "biting" from the "non-biting" Muscidæ is made an excuse for bringing in an excellent description of the mouth-parts of the house-fly.

Chapters v. to x. deal with fleas, bugs, lice, ticks, mites, and the pentastomids or "tongue worms," the latter two groups, although not insects, being usually regarded as coming within the meaning of the term "entomology."

The book is well illustrated, there being eighty-nine plates, the majority of the figures being original sketches by the wife of one of the authors, and many of these indicate a large amount of careful dissection.

There are a few mistakes, such as that in bugs the "mandibles are so opposed as to form a channel with a circular lumen, while the maxillæ are armed with cutting teeth" (p. 6), and there are occasionally definite statements made upon debatable points, as with regard to the number of segments composing the insect head (pp. 9 and 13); but the chief complaint we have to make is against the way the book has been edited. There are, for instance, some sentences which are either difficult to understand or altogether unintelligible. Thus, on p. 7 we read, "In the Diptera . . . the sucking tube is formed by the outgrowth from the pharynx of two spatulate slips, one dorsal and the other ventral," and it is not until p. 21 that we find the real meaning of this extraordinary statement, where it is said, "In the Diptera [the adaptation of the mouth for sucking] is accomplished by the development to a very high degree of just those parts of the mouth apparatus which are rudimentary in the cockroach, namely, the epipharynx and the hypopharynx. These are outgrowths from the dorsal and ventral walls respectively of the stomodæum. . . ."

On p. 15 is the cryptic statement: "When the head [of a fly] is viewed from behind the whole of the posterior wall is seen to be chitinous, while at the lower border there is a rounded foramen between the anterior and posterior surfaces through which the proboscis is protruded."

Again, in various places we find references to earlier passages which it is almost impossible to trace. Thus, on p. 130, "The relations of the hæmatocœle of the proboscis of the fly have been described at some length in connection with the mechanism of the mouth-parts." But there is no section entitled "Mechanism of the mouth-parts"! There is a heading "Mechanism of the proboscis," but the required statement is not there, and it is only from three words in one sentence that one gets a hint, and we ultimately find what we want under "Movements of the Labella" in connection with a description of the proboscis of Musca (p. 46).

One other complaint we make with regard to the difficulty of using the book. In a number of cases there is much lettering on the plates, and there is the greatest difficulty in finding the explanatory pages. There is a page of reference letters to cover plates i. to vii. immediately following plate i. and just before plate viii. is a page to cover plates viii. to xiii, but there is nothing on any of the plates to indicate where the explanatory pages are to be found. Unfortunately also the page of reference letters for plates i. to vii. is almost wholly wrong.

There are thus many faults in the book, and they are the more to be regretted since much of the material is really first-class. It can only be hoped that the work will run to a second edition in which these defects can be remedied.

FRANK BALFOUR BROWNE.

THE INIMITABLE OBSERVER.

Fabre, Poet of Science. By Dr. C. V. Legros. With a Preface by J. H. Fabre. Translated by Bernard Miall. Pp. 352. (London and Leipzig: T. Fisher Unwin, n.d.) Price 10*s.* net.

The Life of the Fly. With which are interspersed some Chapters of Autobiography. By J. Henri Fabre. Translated by A. T. de Mattos. Pp. xi + 508. (London: Hodder and Stoughton, n.d.) Price 6*s.* net.

MANY who have enjoyed Fabre's entomological studies will be glad to have an opportunity of knowing the author more intimately, and we have to thank Dr. Legros for a fascinating biography and appreciation, which has been admirably translated by Mr. Bernard Miall. Jean-Henri Fabre was born at Saint-Léons, in the canton of Vezins, in 1823, some seven years earlier than Mistral. From his childhood he was a lover of nature and poetry, and though he was brought up amid the rudest privations, they did not freeze "the genial current of his soul." As a school-teacher at Carpentras, with 28*l.* a year, often in arrears, he continued his own education, and all was grist that came to his mill. He had an enthusiasm for knowledge—about plants, rocks, coins, mathematics, chemistry, physics, and what not. When he attained his majority he had the courage to marry. A period in Corsica, as a teacher of physics, was marked by a revived enthusiasm for mathematics, and by meeting Moquin-Tandon, who initiated him in the discipline of dissection. The next period was at the Lycée of Avignon; and it was there, in 1854, that a volume by Léon Dufour, then "the patriarch of entomologists," decided his vocation. In spite of having to work excessively hard to keep the family table spread, and in spite of every possible discouragement, Fabre produced in a few years a series of studies which made his reputation among entomologists. As early as 1859 Darwin spoke of him as "that inimitable observer."

There can be no doubt that Fabre's life was terribly severe. An observer of the first rank had to eke out a miserable salary with "abominable private lessons" which spoiled his temper and wasted his energies. His discovery of a profitable way of extracting the pigment of madder was snatched from his hands, and his dream of freedom to follow his vocation faded away. His free popular lectures at the Abbey of Saint-Martial at Avignon are said to have been famous for a generation, but it is more certain that they aroused jealousy and ill-feeling. He was turned out of his house, and might have come entirely to grief had it not been for the kindness of John Stuart Mill, who was then residing at Avignon. After twenty ill-rewarded years of service, Fabre shook off his yoke and retired in 1871 to Orange. He kept things going in a precarious hand-to-mouth fashion by writing introductions to the various sciences, which had a great vogue in their day, and had certainly the great merit of teaching much in a heuristic fashion with the simplest possible apparatus. But Fabre's fine work was ill-paid; the keepership of the Requen Museum at Avignon was taken from him; he lost a son of great promise; he had a very serious illness; his cup of bitterness was full. When his landlord at Orange lopped the double row of plane-trees which formed an avenue before his house, he could endure towns no longer, and retired to the peaceful obscurity of Sérignan—"a quiet corner of the earth which had henceforth all his heart and soul in keeping."

In his hermit's retreat, living an ascetic life, Fabre gave himself up to observation and reflection, and produced the well-known studies—at once poetic and scientific—that fill the ten volumes of the "Souvenirs Entomologiques." After forty years of desperate struggle he had won for himself freedom, and he used it nobly. "For thirty years he never emerged from his horizon of mountains and his garden of shingle; he lived wholly absorbed in domestic affections and the tasks of a naturalist." He remained extremely, sometimes painfully, poor, and was often worried; but he made a big success of his life, and if he has had many hardships and sorrows he has found in the *vis medicatrix Naturae* much more than healing. His wide scientific interests and culture made him an all-round naturalist; his genius as an observer, not equalled since Réaumur, brought him into extraordinarily intimate acquaintance with the objects of his study; his indefinable sympathy helped him in tracking the mysterious paths of instinctive behaviour. It need not be supposed that he has been without exception accurate, for he has sometimes read too much of the man into the beast; but what eyes the man has had! It cannot be maintained that his judgment has always been sound—witness his dogged anti-evolutionism—but there have been few naturalists who have got so near the intuition of life. We would pay homage to the veteran; he has peaceful satisfaction in the twilight of his days for he knows that he has the gratitude of all who love nature.

A good sample of Fabre's essays will be found in the selections from the "Souvenirs Entomologiques" which have been excellently translated by A. Teixeira de Mattos and published under a somewhat inaccurate title, "The Life of the Fly."

The Life of Flies would have been nearer the mark, for most of the essays deal with Diptera. There are others, *e.g.* on pond-life, caddis-worms, insects and mushrooms, which have not much to do with flies, and the interspersing of biographical chapters—charming as they are—removes the book even further from being a unity. The essays, like everything Fabre wrote, are vividly interesting; they discover to us the wonder of life; they set us thinking; they make us wish to go out and observe. The now well-known style suffers necessarily in translation, but it is extraordinarily picturesque and arresting. We confess to getting wearied when the conversationalism and anthropomorphism is too prolonged; but it is marvellously fine. "I pry into life," Fabre said, and these essays give us some idea of his reward. As the translator has done his work well, and will doubtless do more, may we suggest that the repeated wrong use of the term "species" in the notes is irritating, that starfishes cannot be included in the modern use of the word zoophytes, that the natterjack "sometimes as large as a plate," excites remark; and so does "underneath, in a pool of sanies, is a surging mass of swarming sterns and pointed heads. . . ."

AN ITALIAN TEXT-BOOK OF METALLOGRAPHY.

Le Leghe Metalliche ed i Principii Scientifici della Metallografia Moderna. By Prof. Domenico Mazzotto. Pp. xi+421. (Modena: G. T. Vincenzi e Nipoti, 1913.) Price 6 lire.

PROF. MAZZOTTO'S work is the first complete treatise on metallography in the Italian language. It is very similar in scope to other text-books which deal with the chemical rather than the engineering aspect of the subject, and the treatment is throughout mainly theoretical. As might be expected from the nature of the author's original publications, the quantitative interpretation of the equilibrium diagram receives much attention, and the student will find in these chapters a useful review of the possible types of equilibrium amongst alloys. The ternary and quaternary systems, which have been studied chiefly by Italian metallographers, are also described with the aid of diagrams.

This theoretical section is followed by the discussion of a limited number of actual systems, and this part of the work is somewhat less satisfactory. A more critical treatment of the experimental material would have been of great advantage, as several systems are represented by diagrams taken from early investigations, which later researches have shown to be incorrect. The copper-manganese series is a conspicuous example, the maximum in the second diagram being due to the presence of carbon in the materials employed by Wologdine.

Practical methods are only briefly described, but the usual methods of taking cooling curves are illustrated and explained. Several forms of pyrometer are included, however, which are useless for metallographic work, being designed only for the approximate measurement of furnace temperatures in works practice. Microscopical methods occupy only a few pages, but some photo-micrographs are reproduced from well-known sources.

The general sections on physical and mechanical properties, and on the modes of formation of alloys, although brief, are well written, and should serve as an interesting introduction to the subject for students previously unacquainted with it. The impression of metallography which such students will obtain is somewhat one-sided, but the science is new in Italy, and the admirable work which has been done already by such investigators as Bruni, Giolitti, Parravano, and Mazzotto is a guarantee that it will become firmly established there. By the time the author is called on to revise the present book, his attention will probably have been directed to those aspects of the subject which are now unrepresented, and it will be possible, by reducing the disproportion between the several parts, to render an excellent introductory text-book still more valuable.

C. H. D.

OUR BOOKSHELF.

A Practical Treatise on Sub-aqueous Foundations. Including the Coffer-Dam Process for Piers, and Dredges and Dredging, with numerous Practical Examples from Actual Work. By C. E. Fowler. Third edition, revised and enlarged. Pp. xliii+814. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1914.) Price 31*s.* 6*d.* net.

THIS book first appeared in 1898 under the title "The Coffer-Dam Process for Piers." The title was altered in 1904 to "Ordinary Foundations, including the Coffer-Dam Process for Piers." The work now presented under the title given above contains a large amount of new matter, consisting of practical examples of work, much of which has been constructed by the author, or with which he has come in intimate contact in a consulting capacity. Among the new subjects treated may be noted concrete piles, the jetting of piers, metal sheet-piling, the open-dredging process, caisson work and caisson disease, diving, the bearing power of soils.

An attempt has been made to render the book so complete that the engineer may find it un-

necessary to consult other volumes in order to obtain information regarding the subjects covered. We are afraid that this claim is too wide. The engineer will find a great deal of information of a practical character in the volume, together with methods of calculation (often short cuts) which will enable him to carry through his designs, but to understand completely what he is doing he will certainly either have to possess other knowledge or consult other books. For example, in the section dealing with the calculations of piers, footings and retaining walls, earthwork problems are treated sometimes by the wedge theory, elsewhere by Rankine's theory, and again with friction allowance on the wall. Attention is not directed to the differences of these methods. The treatment of the pressures on the base of the wall is not at all clear, and will leave the engineer who uses the method given in a state of uncertainty as to what he has really done.

Principles of Metallurgy. By A. H. Hiorns. Second edition. Pp. xiv + 389. (London: Macmillan and Co., Ltd., 1914.) Price 6*s*.

It is almost twenty years since the first edition of this book appeared. During that time metallurgy has advanced very rapidly, and any new book or new edition which is published should have many novel features to indicate.

The present volume reviews briefly the principal metallurgical phenomena and extraction processes and forms one of a series by the author. It is a work which is intended for use in a technical school and for the instruction of apprentices and other workers engaged in the metal industries and whose employment demands some elementary knowledge of metals, their properties, and methods of production.

As a consequence of attempting to cover the whole field of metallurgy in some 370 pages, the author has treated several sections rather scantily, while others are out of proportion to their importance. Thus, in the paragraph on the Bessemerisation of copper, no discussion is given of the true function of the furnace lining, and although a "more or less basic" lining is mentioned, no stress is laid upon the recent adoption of basic-lined converters. It is noticeable, too, that the author occupies twelve pages in descriptions of various, almost obsolete, chlorination processes for the treatment of gold ores, whereas he dismisses the more important cyanide process in three pages.

The work is suitable to place in the hands of a young student on his earliest venture into the domains of metallurgy, but he would be well advised to pass, at an early stage, to the larger treatises on the subject. W. A. C. Newman.

Gearing: a Practical Treatise. By A. E. Ingham. Pp. xi + 181. (London: Methuen and Co., Ltd., 1914.) Price 5*s*. net.

The object of this volume is to present in a simple manner the general scientific principles which underlie the subject, and to give particulars of the most approved methods of solving problems connected with various forms of gears. Spur, bevel, worm, spiral and helical gears are included, and methods of cutting these gears are explained and illustrated by photographs. The calculations given are of the simplest possible character and should present no difficulty to anyone who knows ordinary arithmetic. Extensive tables are given which will simplify the process of finding the pitch, diameter, and outside diameter of wheels having a given circular pitch. A considerable amount of space is taken up with blacked drawings showing the comparative sizes of teeth having progressive diametral and circular pitches. The latter might have been omitted, and space found for a discussion of the new problems introduced by the applications of helical wheels in marine turbine speed-reduction gears. The desire of the author to keep the matter treated within the limits of simplicity prescribed by the knowledge of the readers he has in view no doubt accounts for the many omissions in an otherwise useful volume.

Historical Sketches of Old Charing: The Hospital and Chapel of Saint Mary Roncevall; Eleanor of Castile, Queen of England, and the Monuments erected in Her Memory. By Dr. J. Galloway. Pp. 82. (London: John Bale, Sons, and Danielsson, Ltd., 1914.) Price 10*s*. 6*d*. net.

These studies in the history of Old London, by the senior physician and vice-president of Charing Cross Hospital, originally published in the hospital *Gazette*, and reprinted for the benefit of that institution, form a useful contribution to local history. The first part contains an account of the hospital and chapel of St. Mary Roncevall at Charing Cross, a branch house of the great convent at Ronesvalles in the western Pyrenees. The London convent owed its foundation to the liberality of William Marshall, Earl of Pembroke, eldest son of the great William Marshall, Protector of the King and his kingdom after the death of John. It enjoyed a long career of prosperity and usefulness until its final dissolution by Henry VIII. in 1544. On the site was built Northumberland House, purchased by the Metropolitan Board of Works in 1874, and now occupied by Northumberland Avenue and the great buildings which flank that thoroughfare.

The second part of the book is an account of the monuments erected to commemorate the death of Queen Eleanor, and the removal of her remains from Harby, near Lincoln, where she died in 1290, to Westminster Abbey. These consist of her tomb in the Abbey, the work of Richard Crandale, and the series of beautiful crosses, of which those at Chepe, Charing (the site now occupied by the statue of Charles I.) Grantham, Stamford, Stony Stratford, Woburn, Dunstable, and St. Albans, have disappeared, while those at Geddington, Northampton, and Waltham survive in a more or less perfect condition. The preparation of this book, with its fine illustrations and copious references to original authorities, was obviously a labour of love, and it forms an interesting addition to the great library of books on Old London.

Kinship and Social Organisation. By Dr. W. H. R. Rivers. Pp. v+96. (London: Constable and Co., Ltd., 1914.) Price 2*s.* 6*d.* net.

DR. RIVERS has made a speciality of the adaptation of the genealogical method to the interpretation of social facts, to which he has devoted much knowledge and hard thinking. In the present collection of lectures delivered at the London School of Economics he uses his special studies of social life in Melanesia to a consideration of the classificatory system, the essential feature of which is the application of its terms, not to single individual persons, but to classes of relatives which may often be very large. The discovery of this system was the work of Lewis Morgan, who, diverting his attention from the facts at his disposal, attempted to formulate a condition of general promiscuity developing into group marriage, a view offensive to his readers and certain to meet with active criticism. His first opponent was J. F. McLennan, who urged that the terms used formed merely a code of courtesies and forms of ceremonial address for social intercourse. Another theory, that of Prof. Kroeber, suggested that the use of these forms does not depend upon social causes, but that they were conditioned by causes purely linguistic and psychological.

Dr. Rivers, after a careful analysis of the facts, has little difficulty in disposing of these theories. He shows that the process of determination of the nomenclature of relationship by social conditions has been rigorous and exact; further, that every detail of these systems has been so determined. "Even so small and apparently insignificant a feature as the classing of the sister-in-law with the sister has been found to lead back to a definite social condition arising out of the regulation of marriage and of sexual relations." The lectures form a useful contribution to the study of the history of human marriage.

The Farm Woodlot: a Handbook of Forestry for the Farmer and the Student in Agriculture. By E. G. Cheyney and Prof. J. P. Wentling. Pp. xii+343. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1914.) Price 6*s.* 6*d.* net.

THIS is an excellent handbook of elementary forestry, specially adapted for the use of farmers and students of agriculture in North America, yet containing much that should be of interest to landowners in this country. There are well-written chapters on practical sylviculture, on forest mensuration, protection and utilisation, on ornamental planting, and about the durability and preservation of timber. A special article deals with the economic position of the forest and the work of afforestation in the modern State. The authors discuss the question of the apportionment of the soil of a country into the two classes of agricultural and forest lands, on the only just basis; a comparison of the net revenues obtainable from the land under other crops, and under trees. Most of us, who regard the United States as producing timber only from her virgin forests, will learn with surprise that already in New England plantations of white pine have yielded six per cent. annually on the investment.

Another chapter is devoted to the history of the forests of Germany, the United States, and Canada. It is satisfactory to hear that although the progress of scientific forestry in Canada has been slow, and dotted with many set-backs, the prospect at present is promising. In the United States the Forest Service has long been at work, and is now carrying out on the extensive territory under its jurisdiction a magnificent programme, in which the question of profit is never forgotten, all its measures being governed by business principles, none of them by sentiment.

Matriculation Mechanics. By Dr. William Briggs and Prof. G. H. Bryan. Third edition. Pp. viii+363. (London: W. B. Clive, University Tutorial Press, Ltd., 1914.) Price 3*s.* 6*d.*

ADVANTAGE has been taken of the publication of a new edition of this well-known class book to add a collection of simple experiments to illustrate the fundamental principles of mechanics. This addition will certainly increase the usefulness of the book.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Renunciation of Honorary Degrees.

I HAPPEN to see in one of the Dutch journals that a number of German men of science have divested themselves of honours bestowed upon them by British universities and learned societies, on account of the war between England and Germany.

Will you allow me to express the hope, by means of this letter, that my British friends will not reciprocate this action by a similar one?

To my mind, worse than the young lives sacrificed, worse than the destruction of ancient monuments of arts and science, is the almost inevitable consequence of this terrible war: the sowing of hatred and distrust between different nations.

Now it is my firm belief that it is the duty and the privilege of scientific men all the world over to do all in their power gradually to allay these feelings of hatred and distrust.

For this reason especially I regret greatly the action of the German "savants," and earnestly pray my British friends to abstain from similar action.

J. P. LOTSY.

Perpetual Secretary of the Dutch Society of Sciences, Haarlem, September 12.

The Green Flash.

As the green flash continues to appear in your columns, may I give some limiting observations. At sea I have always seen it, if the horizon is clear and not too red. It is also well seen over distant mountains in Egypt at rising, when the sky is less red than at setting. The horizon may be as near as two miles, and still show traces of a green edge. At any distance less than five miles the disappearance can be followed up for some seconds by walking up a slope, so as to keep the green edge under continuous observation.

W. M. FLINDERS PETRIE.

The Large Non-Conchoidal Fracture-Surfaces of Early Flint Implements.

WHEN a representative series of flint implements is examined comprising examples of every stage of culture from the Neolithic back to the earliest Chelles-Palæolithic specimens, it will be observed that, generally speaking, the older the implements the less they show small and "dilettante" flaking in their manufacture, and that when the earliest Chelles stage is reached the flints have been fashioned by the removal of large, bold flakes not supplemented by secondary work, such as is to be seen upon nearly all the examples of later cultures.

When a further series of implements is examined which predate the earliest Palæolithic specimens, this peculiarity is seen to be still more marked, the flints in many cases having been fashioned solely by "quartering" blows producing clean, flat fracture-surfaces exhibiting neither well-marked cones of percussion nor conchoidal rippling, such as are so often produced by the more ordinary type of blow. If, as often happened in pre-Palæolithic times, an implement was produced by means of such blows, the flakes would not in the first place exhibit the normal characteristics of human blows, and secondly, many of these flakes would, in the process of manufacturing the implement, of necessity be truncated and their resemblance to accepted "human" flakes made still smaller. Some of these truncated flakes, moreover, at first sight have the appearance of being thermal breaks, and it requires a close and intelligent examination of their surfaces with a high-power lens to discern those small indications which demonstrate that the flakes have been removed by blows. In addition to the cone of percussion and conchoidal rippling which are often produced by a blow upon a flint, *fissures* of varying size are also formed which radiate from the point of impact.

Some of these fissures, which appear to me to represent "tears" made in the flint by the cleaving force of the blow, are very minute, but in nearly every case are capable of discernment with a really good lens. I have found by experiment that the "quartering" blow to which I have referred, though not producing a well-marked cone of percussion, and very frequently no conchoidal rippling, nevertheless gives rise to these small fissures, and that it is generally possible by the evidence they afford to determine the exact "fracturing agent" and the direction in which it has acted.

It seems to me to be necessary for the prehistorian to recognise the real meaning of these peculiar fracture-surfaces of early flint implements, and I think their non-recognition has been the cause of the inability of many observers to accept these specimens as having been humanly fashioned. To those, however, who are familiar with the method of production of such fracture-surfaces it becomes clear that great precision and dexterity are needed to make an implement by means of this particular type of blow, and that in consequence the probability of unguided natural forces having produced them is practically eliminated.

J. REID MOIR.

12 St. Edmund's Road, Ipswich, September 12.

BRITISH AERONAUTICS.[1]

THE fact that methods of experiment and the apparatus used for test have become standardised has rendered it possible to add considerably to the detailed knowledge relating to aeronautics, and the result is reflected in the increased size of the annual volume published by the Advisory Committee for Aeronautics. The amount of test-work still called for is enormous, and for some time to come problems will need to be taken in order of urgency, whilst many problems of great scientific interest are left for later consideration. Amongst such problems may be classed the mathematical investigation of motion such as that illustrated in Fig. 1, which shows a photograph of fluid motion round a model of an aeroplane wing. The photograph had a time-exposure of about one second, and the lines indicate the direction of the flow, and their length the mean velocity. So far no promising hydrodynamical analysis has been found for such a flow.

FIG. 1.—Flow round aerofoil inclined at 16°. From "Technical Report of the Advisory Committee for Aeronautics for the Year 1912-13." By permission of the Controller of H.M. Stationery Office.

The report deals with quite different subjects, and relates almost entirely to the experimental determination of the forces and couples acting on models immersed in a moving fluid. A considerable range is covered in relation to parts of aeroplanes, and it is now possible to make a good prediction of the resistance of a new flying machine from the resistances of its component parts. One section of the report shows how model results are applied to full-scale work at the Royal Aircraft Factory.

The report is concerned, on the model side, almost entirely with results obtained in the new four-foot channel at the National Physical Laboratory. The original channel, although very useful, was not considered to be satisfactory apparatus for the permanent equipment, and a series of experiments on model channels and buildings was undertaken in order to find, if possible, some design for a channel which would lead to improved steadiness of air-flow. The production of

[1] "The Technical Report of the Advisory Committee for Aeronautics for the year 1912-13." Pp. 416. (London: Wyman and Sons, Ltd., 1914. Price 10s.

such a channel proved to be very difficult, and the more important of these difficulties are illustrated by records of fluctuations obtained. A satisfactory design was ultimately obtained and put to a full-scale test in the new four-foot channel shown in Fig. 2. The results of this final test were considered to be quite satisfactory, and since that time a three-foot channel has been erected and put into use, whilst a seven-foot channel to the same general design is nearly completed. An almost exact copy of the four-foot channel has been erected at Boston, U.S.A.

From the figure it will be seen that the channel consists of a square trunk, the part from the left to the centre being the working section in which uniform flow is required. The fan is four-bladed

large bodies of air without the production of vortices is the great problem in the production of a steady wind-channel.

Not only has the air-flow been rendered satisfactory, but the aerodynamic balance has been redesigned and rendered suitable for work of the most general description. It is possible, and has, in fact, become part of the regular work of the National Physical Laboratory, to measure all the forces and couples acting on any body, however unsymmetrically placed on the wind. The precautions taken in the setting of the balance are described in some detail in the report, and show that considerable care is essential to success; the order of accuracy required can be realised from the fact that to obtain the resistance of an aero-

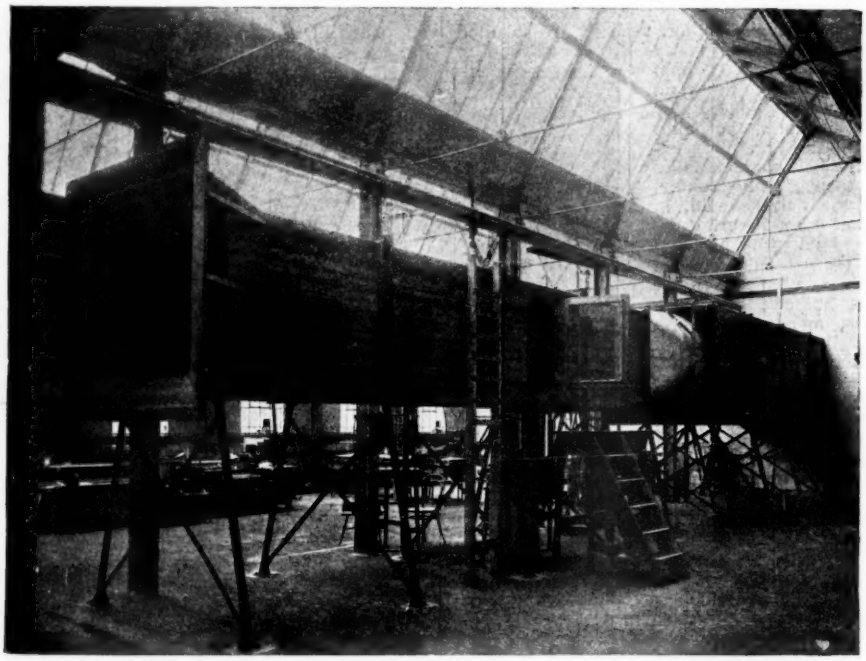

FIG. 2.—General view of the new four-foot wide channel, showing trumpet intake, working section of the channel, and distributor. From "Technical Report of the Advisory Committee for Aeronautics for the year 1912–13." By permission of the Controller of H. M. Stationery Office.

and similar to an aeroplane propeller, and is situated in the short circular section to be seen just past the steps. This propeller draws air at speeds up to 50 ft. per sec. through the bell-mouth and a honeycomb, past the model, and through a second honeycomb, finally delivering the air into the perforated chamber or distributor seen to the right of the picture. The air leaves the distributor at speeds less than 3 ft. per sec., and the disturbance of the air cannot easily be detected except within a foot or so of the perforations. The first honeycomb has a use not readily suspected; miniature whirlwinds form on the floor of the building, and unless broken up by a honeycomb, the result on the model is a succession of blows at uncertain intervals. The movement of

plane wing correct to 1 per cent. the wind-direction must be known to within 0·05° relative to the arms of the balance.

There is one measurement other than those provided by the balance which is necessary before the results can be expressed in absolute units, viz. the velocity of the air-current. Experiments have been carried out on the whirling arm of the National Physical Laboratory, from which it has been possible to fix the constant of a standard anemometer to 0·1 per cent., an accuracy which makes the uncertainty in absolute value far less than the errors of observation in most experiments for aeronautical purposes. The accuracy of aeronautical experimental work is often limited by the effects of apparatus for holding the models, and

one of the recurring difficulties is that of reducing such interferences until they are small enough to be dealt with as corrections.

Almost all the numerical data given in the section relating to full-scale machines are derived from the results of experiments on models in a wind-channel. Care is necessary in making the application, and the report contains a comparison between tests on model and full-scale wings. The law of dynamical similarity indicates the possibility of a difference, and although the experimental results are not all that could be desired, they furnish a first approximation to one of a series of scale correction factors.

As a result of model experiments it is now possible to try full-scale experiments of a somewhat detailed character.

Other parts of the report deal with calculations of the stresses in the wings of aeroplanes, both in the internal structure and in the fabric. Systematic investigation of the strength and extensibility of fabric used for aeroplane covering is in progress. The report generally gives detailed descriptions of each of the tests, the results being expressed in many cases in the form of curves.

THE BRITISH ASSOCIATION IN WEST AUSTRALIA.

PERTH, AUGUST 4.

THE Australian meeting of the British Association has already been very successfully inaugurated, to-day being the last spent by the advance party in Western Australia and the first of the main party travelling by the *Orvieto*.

The Western Australian delegation, numbering close on seventy visitors, has remained a week in the Western State, and this time has been devoted almost entirely to practical work in the country and on the sea. The Western Australian committee from the very first aimed at giving the guests a full week of collecting and investigating, and consequently receptions, garden parties, etc., have been strongly suppressed. That this has been a huge success is evident from the opinions of the visiting men of science, who

FIG. 3.—BE2 showing fin experiment F and buffer landing gear B. From "Technical Report of the Advisory Committee for Aeronautics for the Year 1912–13." By permission of the Controller of H.M. Stationery Office.

The test illustrated in Fig. 3 relates to the automatic banking of a flying machine, and the detail changed is the upper end of the wing struts. These had been shown by model experiments to become effective fins and therefore suitable for such an experiment.

For measurements of the resistance of hydro-aeroplane floats apparatus must be used in which the surface waves can be reproduced, and work of this character is carried out in the William Froude National Tank. The report gives drawings and the results of experiments for a new type of float having a low resistance.

consider their week of research in Western Australia has amply repaid them for their long journey from England. No meetings of sections have been held whatever. A number of visitors, chiefly botanists, zoologists, and geologists, arrived early in July in order to spend two, or even three, weeks in the State ending with the official week. The official party arrived by the *Ascanius* on July 28 and the P. and O. mailboat of the same date.

Hospitality had been previously found for all the visitors, and the Government of Western Australia had provided funds for official excursions during the week for the botanists, zoologists, and geologists, together with free railway passes over the State railways.

A very well illustrated handbook had also been printed, and was distributed to the guests on arrival. This handbook is on somewhat different lines from those of the other State handbooks, the articles being chiefly on the sciences represented by the visitors. The various sections include a general introduction by the Hon. W. Kingsmill (chairman of the executive committee in Western Australia); agriculture and climate, by W. Catton Grasby; botany, by C. Andrews and Mrs. C. M. G. Dakin; geology, by A. Gibb Maitland; mineralogy and mining, by A. Montgomery; and zoology, by Prof. W. J. Dakin and W. B. Alexander.

On the day of arrival of the visitors Sir Harry Barron, the Governor of Western Australia, held a reception at which about 2,500 guests were present. The first British Association evening discourse was given the same evening by Prof. Herdman, the title being "Why we Investigate the Ocean," and was very largely attended. Three other lectures have been given in Perth during the week and one in Kalgoorlie. The subjects of the Perth lectures were, "Stars and their Movements," by Prof. Eddington; "The Primitive Methods of Making Fire," by Mr. H. Balfour; and "The Electrical Action of the Heart," by Dr. Waller. The Kalgoorlie lecture by Mr. Buckmaster was on mining education in England.

The excursion parties left Perth on Wednesday morning, the day after arrival, with the exception of a small party of keen geologists which started away under the leadership of Prof. Woolnough, of the University of Western Australia, on the previous day.

Prof. W. J. Dakin, one of the local secretaries for the Western Australia meeting, conducted a large party of zoologists to the famous Yallingup and Margaret River caves, situated near the coast in the south-western corner of the State. This expedition, favoured by remarkably fine weather (exceptional for the season of the year), afforded not only a glimpse of the south-west region, where rain is abundant and the vegetation has many peculiar characters, but enabled the zoologists to visit the deposits where such excellent discoveries of fossil giant marsupials have lately been made by the Western Australian museum staff. These investigations have been carried out through the munificence of Sir Winthrop Hackett by Mr. Glauert. The remains include bones of two species of diprotodon, the Tasmanian wolf (*Thylacinus cynocephalus*), the Tasmanian devil (*Sarcophilus harrisi*), a giant Echidna (*Zaglossus hacketti*), and a giant kangaroo. Space forbids a description of the cave formations—the caves are water-formed chambers in a soft limestone which is due itself to the action of atmospheric agents on great accumulations of drift sand. The second large zoological excursion was a motor run from Perth to Mundaring Weir. A hunt was made for arthropods, the greatest interest centring, of course, round Peripatus. About seventy-five living specimens of the latter (*Peripatoides gilesii*) were collected by the party in a few hours. This excursion was also under the leadership of Prof. Dakin.

The zoologists completed their investigations by a dredging expedition on almost virgin ground, turning up many species new to Western Australia.

The botanists were extremely enthusiastic, and well they might be, for Western Australia is without doubt the pre-eminent State as a "botanist's paradise." To quote the words of Mr. C. Andrews, who was leader of all the botanical excursions, "Nearly four thousand species have already been described, and of the four thousand species about two-thirds are endemic."

The botanists commenced work with an excursion to the Darling Ranges, which occupied a full day. On the following day a longer excursion was made, and the party visited a sand-plain district, making their headquarters at the Benedictine Monastery at New Norcia. The third excursion took the party to the interesting Albany district, where, amongst other plants, the famous Cephalotus (the Western Australian pitcher plant) lives. The most interesting plant collected here was Phylloglossum, but very large collections of the Proteaceæ and other characteristic plants were made.

The geologists had a most strenuous week, especially since some of them had put in a hard week immediately before, for the two official excursions covered a fortnight altogether. The first visitors left Perth for Mingenew (two hundred miles north), and spent three days travelling through the Irwin River Valley and examining the Permo-Carboniferous Glacial beds, Marine beds, and Coal Measures. Two more days were employed in excursions in the vicinity of Perth, and the visitors left for Albany on Monday night (July 27). On the following day the geologists of the main Western Australia party arrived and proceeded to Mount Barker (three hundred miles south), meeting the others at that place. The whole party, under the guidance of Mr. H. P. Woodward, acting Government geologist, motored to the remarkable quartzite mountains of the Stirling Range. The last few days were spent in and about the goldfields.

In completing an account of the week in

Western Australia mention must be made of the excellent arrangements for those visitors who were desirous of seeing as much as possible of the State but were not taking the official botanical, geological, and zoological excursions. Mr. Catton Grasby piloted Mr. Golding round the agricultural districts. Mr. Kingsmill and Mr. Battye arranged a week's programme of short local excursions. The Government very kindly arranged a particularly interesting excursion to the timber district at Big Brook and ran a special train, the Premier himself making one of the party. Prof. Ross guided a number of visitors over the wireless telegraphic station, and Prof. Whitfeld conducted a small party to Kalgoorlie.

Special arrangements were made for the overseas party travelling by the *Orvieto* and only having a few hours in Western Australia. The Mayor of Perth entertained the party to luncheon, after motor drives had been taken round Perth. This completed the official visit to Western Australia. Whilst this is being written upon the *Orvieto en route* for Adelaide the party is anxiously waiting for news of the trouble at home, a few tragic rumours having just reached us as we left Perth for the steamer. W. J. DAKIN.

DR. W. H. GASKELL, F.R.S.

DR. GASKELL'S unexpected death comes as a shock to his many friends. A few weeks ago he was in full enjoyment of life. His sixty-seven years were lightly borne, and the ailments inseparable from his years had little effect on his buoyant nature. He was actively engaged in putting in book form his views on the sympathetic system, and no one doubted that he had years of barely abated vigour before him. He died on September 7 after a short illness.

Gaskell entered Trinity College, Cambridge. In 1869 he was placed among the Wranglers in the Mathematical Tripos, and in 1872 he took honours in the Natural Science Tripos. He proceeded to a medical degree, and under the influence of Michael Foster began research in physiology. Carl Ludwig's laboratory in Leipzig was the principal centre of physiological research, and Gaskell went to Leipzig. Under Ludwig's direction he investigated the vaso-dilator fibres of muscle. The resultant paper is one of the classical works on the subject.

On returning to Cambridge Gaskell took up the study of the mechanism by which the several parts of the heart are coordinated in the sequence of contractions which make up the heart-beat. At this time the dominant—though not unquestioned—theory referred the sequence of contractions to the activity of separate groups of motor and inhibitory nerve-cells placed in the heart itself. Gaskell at first supported this hypothesis with certain modifications, but as the result of later investigations chiefly on the heart of the tortoise, he substituted for it the theory, now almost universally adopted, that the conduction of impulses from one part of the heart to the next is by means of a specialised muscular tissue. At approximately the same time Engelmann contested the theory of nervous control, and the modern views of the mechanism of the heart-beat are inseparably connected with the names of Gaskell and Engelmann. Gaskell's work was full of new and important observations. Thus he described how, by lowering the conductivity of the tissue between the auricle and the ventricle, the ventricle only responded to every second and third contraction of the auricle. On the invention of the string galvanometer by Einthoven, the "heart-block," described by Gaskell, explained certain irregularities observed in the cardiac tracings of man, and became of fundamental clinical importance.

In connection with the foregoing work, Gaskell investigated the extrinsic nervous supply of the heart, *i.e.* its innervation by the vagus and sympathetic nerves. He was thus led to his next great line of work, that on the sympathetic nervous system. On this question there were a vast number of observations, but for the most part they were disconnected, and few generalised statements had any currency. A distinction of white and grey rami connecting in the mammal the spinal nerves with the sympathetic had long been known, and Onodi and others had described the absence of white rami in the cervical, lower lumbar, and sacral regions. The white rami were known to be composed chiefly of myelinated nerves and the grey rami of non-myelinated nerves. Gaskell's observations were chiefly microscopical. He noted that the roots of the spinal nerves at their origin from the spinal cord had no non-myelinated nerve fibres, and from this and other facts he deduced as a broad general statement that the outflow of nerve fibres from the spinal cord to the sympathetic chain took place solely, or almost solely, in the regions in which white rami were present, *i.e.* in the thoracic and upper lumbar regions. In Gaskell's paper there are other generalisations with regard to the sympathetic and allied nervous systems, but it would take too much space to discuss them here. It must suffice to say that Gaskell was the first to attempt to treat the innervation of the blood-vessels and the viscera in a comprehensive manner.

Gaskell's study of the relation of the central nervous system to the sympathetic nervous system in vertebrates led him to consider the relation of both to the nervous system of invertebrates, and he passed from the more special domain of physiology to that of morphology. He arrived at conclusions differing essentially from that held by morphologists, and the remaining years of his life were mainly occupied in advocating his views and working them out in detail.

Taking Gaskell's work as a whole, it appears that the main bent of his mind was for generalisation. It was scarcely possible for him to make an experiment without extending the conclusions to be derived from it to a number of other phenomena. It was both his virtue and his defect. His influence on physiological conceptions has

been widespread, and it will be long before he ceases to be a living force and passes to the position—honourable as it is—of an historical figure in physiological science.

Gaskell cared little for public ceremonies, and rarely attended the congresses which beset the path of prominent scientific men. He loved to work quietly, to cultivate his garden, to see his friends, and to take a hand at whist or bridge. His house at Great Shelford was a recognised meeting-place for physiologists, and his frank and genial welcome will be an abiding recollection to all who knew him. J. N. LANGLEY.

NOTES.

WE learn from a paragraph in the *Times* of September 19 that the question of abandoning honorary degrees received from English universities, and distinctions from learned societies, is being discussed by some German professors. Prof. W. Förster, professor of astronomy in the University of Berlin, who holds a doctor's degree at Oxford, takes objection to the movement in a letter to the *Berliner Tageblatt*, on the ground that it is unwise to proclaim a divorce from the "learned world" of England because of England's "wicked policy." It would be better for the German professors to make a strong appeal to their English friends for "a more effective loyalty to the intellectual community." Protests against Prof. Förster's views promptly came from Profs. Eucken and J. Kohler, who hold chairs of philosophy and law respectively. In connection with this question we are glad to print elsewhere in this issue a letter from Dr. J. P. Lotsy asking scientific men who have received honours from universities, or other learned institutions of nations with which their own countries are at war, not to commit the act of renunciation advocated by certain representatives of German learning.

WE are glad to see in Tuesday's *Times* a letter from Prof. J. A. Fleming dissociating scientific work from the spirit of Prussian militarism. In the course of his letter, Prof. Fleming says:—"No one familiar with the achievements of scientific thought would refuse to admit the indebtedness of the world to such thinkers and workers as Jacobi, Gauss, Bessel, Riemann, H. F. Weber, von Helmholtz, Kirchhoff, Hertz, and Röntgen, but the fact is quite as astonishing as it is painful that a nation which has made such contributions to the upbuilding of natural philosophy should have permitted itself also to be dominated by an immoral militarism by whose votaries sheer brute force is worshipped as the highest virtue and the only source of national advancement. Side by side with immense ability in creating and applying scientific knowledge we have an almost complete failure to recognise truth, honour, faith-keeping, and justice as the foundations of national greatness. Germany has no greater need at the present moment than some inspired prophet to enforce on her the truths of which Thomas Carlyle was so eloquent an exponent—namely, that physical force is in the long run impotent unless backed by those spiritual forces which spring only from loyalty to the everlasting difference between right and wrong."

WE learn with regret that Dr. H. J. Johnston-Lavis, professor of vulcanology in the Royal University of Naples, was killed in a motor accident at Bourges early this month.

WE regret to announce the death of Sir Henry G. Howse, at one time senior surgeon to Guy's Hospital, and president of the Royal College of Surgeons, England. He was eminently a practical surgeon, making numerous contributions to the medical literature of his time. Some years ago he retired from active practice, and settled near Sevenoaks, Kent, where he enjoyed a well-earned leisure. He was in his seventy-third year.

THE death is announced at Louth, Lincs., of Mr. George Gresswell, formerly lecturer in physical science, under the Government of the Cape of Good Hope, at the Diocesan College, Rondebosch, and demonstrator of practical physiology and histology at Westminster Hospital. Mr. Gresswell was the author of a number of books and papers, including several on the theory of evolution.

FROM telegraphic messages issued through Reuter's Agency we learn that the United States Revenue cutter *Bear* on September 8 rescued eight members of Mr. Stefánsson's Canadian Arctic Expedition, who were marooned on Wrangel Island. It is reported that Mr. Mallock, the geologist, and Mr. Mamen, the topographer to the expedition, died on Wrangel Island. The absence of news leads to the fear that M. H. Blanchet, of Paris, Dr. A. Mackay, and Mr. James Murray, other members of the expedition, may have been lost. Mr. Stefánsson himself and three others are said to be safe and to be drifting towards King William Land.

SIR ERNEST SHACKLETON and the members of the Trans-Antarctic Expedition left London on September 18. Those members of the expedition proceeding to the Ross Sea travelled *viâ* Tilbury for Tasmania; the others, the Weddell Sea section, included Sir Ernest Shackleton, and embarked for South America. The Ross Sea party expects to sail from Hobart in the *Aurora*. The Weddell Sea contingent hopes to leave Buenos Aires on October 18 by the *Endurance*. After landing its party the *Endurance* will return to the Falkland Islands, whence news of the explorers may be expected next January. If Sir Ernest Shackleton's land party does not cross the Antarctic Continent during the first season it has been arranged that the *Aurora* shall winter in the Ross Sea. Sir Ernest Shackleton hopes to meet the Ross Sea party either in April of next year, or, failing that, in March, 1916.

UNIVERSITY COLLEGE, Galway, has, during the summer vacation, suffered a great loss by the death of Prof. R. J. Anderson, professor of natural history in the college. Dr. Anderson was greatly beloved by his colleagues and his students. He was a genuine scholar, with few interests outside the world of science. With his wife (a sister of Prof. John Perry, of South Kensington) he was a constant attendant at the meet-

ings of the British Association and the British Medical Association. He graduated in the Queen's University of Ireland, and afterwards studied at London, Leipzig, Paris, Heidelberg, and Naples. For eight years he was lecturer on anatomy and assistant professor of physiology in Queen's College, Belfast, and for more than twenty-five years he occupied the chair of natural history in Galway. He was co-editor of the *International Journal of Anatomy and Physiology*; was an honorary president at Lisbon Medical Congress, Sec. Intermediate I.; an honorary president at Buda Pesth Medical Congress, Sect. Board II.; a vice-president Anatomical Section, British Medical Association, at Glasgow. He made a speciality in his studies of vertebræ skeleton and mammalian morphology. His published works include "The Elephants" (1895), "The Whales and Dolphins" (1896), "Chelonia" (1912), and "German Influence: Intellectual and Moral" (1896). Dr. Anderson graduated M.A. with the highest honours in the Queen's University, and at the examination for the M.D. degree of that University he obtained first place, the Peel scholarship, and a gold medal. He was a member of the Royal College of Surgeons (England).

In *Man* for August Dr. S. N. Shannus describes a form of iron-smelting furnace used by the Angonis of Nyasaland. The furnace is about 10 ft. in height, bottle-shaped, and made of clay, supported by wooden poles let into the ground, bound round the outside. At the base there are eight holes through which earthenware pipes having an internal diameter of 3 in. are inserted to create the draught. The furnace is built on a slight slope, which allows of a hole being made at the lower side from which the slag escapes. A rough platform of logs is made up against the upper side for the convenience of those filling the furnace. It is filled almost to the neck with charcoal, which is ignited from the top, and a mixture of charcoal and iron-stone in equal proportions is added at intervals. The operation lasts for two days, when an opening is made at the base of the furnace, and the iron, which has collected in a circular trough at the bottom, is extracted.

Mr. A. D. Passmore discusses in *Man* for August the reason for the absence of large flint implements in Gloucestershire. In this district there is no indigenous flint, and the raw material was probably imported from Wiltshire. In Wiltshire, where flint is common, a man who broke a large axe could afford to throw the pieces away and pick up a fresh lump to replace it. But in Gloucestershire the reverse would be the case, and the pieces would immediately be used up to make arrowheads, scrapers, and the like. At Windmill Hill, near Avebury, Wilts, flakes and pieces of flint which were once obviously parts of axes have been found in great numbers. It has been supposed, in order to explain this fact, that a successful invading race of bronze-using people went round after the conquest smashing up the flint weapons of their victims. This is, he thinks, more probably due to the fact that working material of tried value was used in preference to that which was not tried, and the fragments were the waste remaining after the conversion of broken implements into smaller articles. As a parallel, he quotes the case of a repairer of old furniture using an old table-top which bore a peculiar yellow polish, with the result that small pieces bearing this peculiar polish could be picked up in all corners of the workshop.

In the report of the Otago University Museum for 1913 it is recorded that considerable additions have been made to the Hocken library, the principal contributors being Mrs. Hocken herself and Mr. Trimble. The curator laments that school teachers neglect the opportunities offered by the museum for instruction in nature-study.

According to the report for the year ending June 30, 1914, the most important recent addition to the natural section of the Warrington Museum is the herbarium of the late Mr. W. Hodge, of Northwich, which was acquired by purchase. It includes 931 sheets of flowering plants, representing 824 species, and 121 sheets, with 115 species, of mosses, together with five volumes of notes. Nearly half the specimens were collected locally.

The biology of humble-bees and honey-bees and the various forms of cells constructed by different kinds of wasps are discussed by Mr. O. J. Lie-Pettersen in the combined July and August number of *Naturen*. Another article on bees appears in the August issue of the Proceedings of the Philadelphia Academy, in which the author, Dr. N. E. McIndoo, describes the scent-producing organ of these insects. This organ, situated between the fifth and sixth abdominal segments, is furnished with gland-cells, which were long considered to be for the purpose of secreting perspiration, but their true function was pointed out by Sladen in 1902. Apparently these glands secrete a volatile substance, which collects in a special reservoir (ampulla), whence it passes through a chitinous tube to a canal on the dorsal surface of the abdomen. So long as the abdomen remains straight, the canal is well protected, and the liquid can only evaporate slowly; but directly this part of the body is strongly flexed, the entire canal is more or less fully exposed to the air, in which the odour of the evaporating fluid becomes rapidly diffused.

A geological map of Nova Scotia in one sheet, on the scale of one inch to eight miles, has been issued by the Geological Survey of Canada. The Palæozoic sequence is remarkably complete. While the crystalline rocks of Cape Breton Island are clearly pre-Cambrian, a Devonian granite is prominent in the south-west of the country, where it forms the watershed. North-west of it, the coastline of the Bay of Fundy is moulded on the strike of a long band of Triassic dolerite.

Dr. F. R. von Huene, of Tübingen, summarises the conclusions of his recent work on Dinosaurs in the *American Journal of Science*, vol. xxxviii. (1914), p. 145. He urges that the dinosaurs are not a natural order, and that Seeley's two divisions, the Saurischia (=Theropoda+Sauropoda) and Ornithischia (=Orthopoda), were separately derived from the Pseudosuchia. References are given to his three papers published in Germany in the present year.

THE production of amphibolites, rocks rich in hornblende, felspar, lime-garnet, etc., through the alteration of limestone invaded by a granitic magma, presents features of chemical as well as geological interest. A notable addition to the work done in France, Canada, and elsewhere is made by P. P. Sustschinsky (*Trav. Soc. imp. Naturalistes St. Pétersbourg*, vol. xxxvi., livr. v.), who illustrates a number of examples of contact-alteration from south-west Finland. A German summary is provided.

THE memoir of the Geological Survey of England and Wales on the geology of the northern part of the Derbyshire coalfield (price 3*s*.), by W. Gibson, C. B. Wedd, G. W. Lamplugh, and others, will be of interest to many besides professed geologists. The area includes Matlock and the famous Creswell Caves, rich in Pleistocene mammalia, and excellent photographs are given of this land of limestone crags. L. Moysey contributes classified lists of Coal-Measure fossils, occupying twenty-two pages, which will be of service to workers throughout central England.

THE stratigraphy of New Zealand has been so retarded, and, it may be added, confused, by the imperfection of the palæontological data, that we welcome the Palæontological Bulletin No. 1, issued by the New Zealand Geological Survey. In this quarto memoir, J. A. Thomson brings together materials for the palæontology of New Zealand, including a list, with references, of all the known pre-Cretaceous fossil species of the country. Plates that have been long in stock are now issued with this publication. We note what is perhaps an appeal to a new group of helpers in national scientific work in the addition of Maori names for the islands, and for New Zealand itself, in the two topographical maps that are so well provided.

So much interest has been attracted to the antarctic regions that it may be well to mention a paper published in the *Cairo Scientific Journal*, vol. viii. (1914), p. 77, by H. T. Ferrar, who accompanied the *Discovery* in 1901. The summary of geological conclusions indicates the occurrence of both "Atlantic" and "Pacific" types of crust-structure in the antarctic continent. The author urges that the shrinkage of the glaciers is due to decreased precipitation on the higher ground, and that the cause of this is "a general lowering of the temperature of the polar atmosphere." It must be remembered, on the other hand, that ice-sheets may be nourished by small annual precipitation, provided that the conditions are cold enough to reduce the loss by evaporation and ablation. Geographers may overlook this paper in an Egyptian journal, and may also be glad of a reference to a description by W. Bellows, accompanied by a good panoramic photograph, of the rarely seen arctic island of Jan Mayen. This appeared in the Proceedings of the Cotteswold Naturalists' Field Club, vol. xvii., p. 333.

WITHIN less than a year seismology has lost two of its leading students. Prof. Milne died on July 31, 1913, and Prof. G. Mercalli, through fire in his house at Naples, on March 19, 1914. Born on May 21, 1850, and therefore only a few months older than Milne, Mercalli's attention was concentrated at an early age on the study of volcanoes and earthquakes. His first important work was that on the "Vulcani e fenomeni vulcanici in Italia" (1883), which formed the third part of the "Geologia d'Italia" by G. Negri, A. Stoppani, and G. Mercalli. In partnership with Prof. T. Taramelli, who contributed the geological parts of the reports, he studied the Andalusian earthquake of 1884 and the Riviera (Ligurian) earthquake of 1887. In 1902, he proposed the modification of the Rossi-Forel scale of seismic intensity which now bears his name, and is widely, almost universally, used throughout Italy. As a seismologist, Mercalli will perhaps be remembered chiefly for his contributions to the physiographic side of his science. He prepared a general catalogue of Italian earthquakes from 225 B.C. to A.D. 1859, and the generosity of his disposition is shown by the help which he gave to Dr. Baratta in the work by which this catalogue has now been superseded. One of his earliest detailed studies of earthquakes was that on the destructive Ischian earthquake of 1883; and he has since (1897) published important memoirs on the earthquakes of Liguria and Calabria. Few, if any, of the Italian volcanoes have escaped the attention of Mercalli, but to the Vesuvian phenomena he devoted unremitting study for a period of about twenty years. An admirable summary of his scientific work by Dr. E. Oddone appears in the last *Bollettino* of the Italian Seismological Society (vol. xvii., pp. 245–262).

IN view of the unfortunate interruption to the useful work of the international exploration of the upper air, owing to the war now raging over Europe, it is satisfactory to note that there are several stations in the British Isles at which such observations are regularly made. The annual supplement of the *Geophysical Journal*, 1912, recently published by the Meteorological Office, contains a summary of the records of registering balloon ascents at six stations, and additional data not included in the monthly issues. The results of fifty-two successful ascents were published during the year in question, and it is stated that there was scarcely a single failure in obtaining a trustworthy record up to at least 10 km., but that the year was an unfortunate one in the matter of finding the balloons. The more salient features of each ascent are brought together in one table and expressed in international units, from which, among other interesting results, it is seen that the mean height of the base of the stratosphere was 10 km., and the corresponding temperature 218·5° A. (273° A.=0° C.); temperature at the mean maximum height reached (14·7 km.) 221°; mean temperature of the air column between 1 and 9 km., 251·8° It should be noted that most of the ascents were made in the summer season. Out of the falling points of the balloons there were twenty-two in the S.E. and fourteen in the S.W. quadrant; the preponderance of falls in the former quadrant agrees with continental observations.

IN the Memoirs of the Indian Meteorological Department (vol. xxi., part ix.), Dr. G. T. Walker publishes a short note on the criterion for the reality of

relationships or periodicities. If an attempt is made to correlate a pair of variable quantities there is a certain measure of correlation to be expected even in the absence of any definite relationship. This measure must be sensibly exceeded if the result actually found is to be treated as an indication of causal connection. When, however, a whole set of correlations is determined the fortuitous element will occasionally be largely exceeded without indicating a real relation. Similarly, when a complete periodogram is investigated the largest ordinate must exceed the probable measure by a large factor if the corresponding periodicity is to be regarded with any confidence. The outcome of Dr. Walker's paper is a table giving the ratios of the greatest of an assigned number of (1) accidental correlation coefficients, (2) amplitudes of periodicities, to the probable value of a single one. The note illustrates the need for extreme caution in interpreting the results of work of this kind. But it does not touch the real difficulty of periodogram analysis. This consists, in the language of the optical analogy, in the occurrence of banded spectra. Until this feature becomes amenable to sound interpretation, the periodogram method, always painfully laborious, is likely to remain absolutely sterile.

FROM the recently issued report of the Government Chemist (Cd. 7562) we learn that a large number of determinations of the salinity of sea-water were made last year at the Government Laboratory, for the information of the Permanent International Council dealing with the exploration of the sea. More than four thousand samples of sea-water were taken by steamships on various routes and by lightships round the coast, and forwarded for examination. The data relating to the specimens from the Atlantic routes are published with the monthly charts issued by the Meteorological Office. It is noted in the report that the chemical work of the Geological Survey is in future to be performed by the staff of the Government Laboratory, and arrangements have been made for this purpose. During the year an extensive series of experiments was conducted in connection with the measures to be taken for the preservation of the roof of Westminster Hall; the results are not stated, but a summary of the conclusions arrived at has been published as an appendix to the report of the architect in charge of the work. There is an interesting reference by the Government Chemist to the composition of a series of medieval wax seals, of various dates from the thirteenth to the sixteenth centuries, which were examined for the Record Office. An impression of the Great Seal of 1350 was found to consist of pure beeswax which, although nearly six centuries old, corresponded exactly in properties with wax of recent origin. Among other matters of interest mentioned are some experiments upon the keeping of milk in galvanised-iron vessels: the results showed that at the end of twenty-four hours the milk had dissolved zinc equal to about half a grain per pint, and also traces of antimony and arsenic. There was a large increase in the total number of samples examined last year as compared with the previous year, the respective numbers being 234,754 and 209,502.

PART v. of vol. xxvi. of the Proceedings of the Physical Society of London consists of 114 pages of papers communicated to the society, the index to the volume and the proceedings at meetings of the society during the session 1913–14. Readers of the Proceedings will, we feel sure, cordially welcome the issue of them with their edges cut. It will be noticed that the society has a committee on nomenclature and symbols which makes a provisional report on electric and magnetic symbols in the present number. Communications dealing with electrical subjects show a marked preponderance over those relating to other branches of physics. Of the electrical papers may be mentioned Mr. F. E. Smith's on a variation magnetograph, Mr. F. Mercer's on the arc electric wave generator, Prof. Fleming's on the bending of such waves round the earth, and Sir Joseph Thomson's account of his search for waves still shorter than those hitherto produced. A paper by Mr. T. Barrett deals with the thermal and electric conductivities of rare metals, and one by Prof. Lees with Fourier series and the method of least squares.

PROF. F. C. LEA, of the University of Birmingham, and Mr. O. H. Crowther give an account in *Engineering* for September 18 of some experiments on reinforced concrete beams. In these experiments the longitudinal strains of a part of the beam subjected to uniform bending moment were measured by a special type of extensometer. From the resulting curves, it appears that the ordinary assumption that the distribution of stress is linear on the compression side of the neutral axis is approximately correct. The experiments show also that the modular ratio diminishes as the stress increases, and is slightly higher for the richest mixture than for the poorer mixtures. The evidence so far is opposed to the recent London County Council Regulations, but the authors consider that it is desirable that the experiments should be continued, and have made arrangements for this to be done.

OUR ASTRONOMICAL COLUMN.

A NEW COMET.—It is announced that a bright comet was discovered at the Cape Observatory on September 18. The comet was then near the star Achernar (α Eridani), and therefore invisible in the British Isles.

COMET 1913*f* (DELAVAN).—Comet Delavan is now beginning to diminish more rapidly its northern declination, but is still a circumpolar object, and therefore visible throughout the whole night. It is a conspicuous object to the naked eye, and lies nearly on the prolongation of a line towards the horizon joining the two pointers (α and β) in Ursa Major. This position can be easily found by consulting the chart given in this column for September 3. The comet is steadily increasing in brightness, and its tail has considerably increased in length. The dark nights recently experienced have been very favourable, both for visual and photographic work, and no doubt a large harvest of data is being collected.

M. Bigourdan, in the *Comptes rendus* for September 7 (tome clix., No. 10), gives some observations for position of this comet which he made at the Paris Observatory on September 2 and 3.

HYDROGEN LINES AND SERIES CONSTANT.—Under the heading "Wave-lengths of Hydrogen Lines and Determination of the Series Constant," Mr. W. E. Curtis recently communicated through Prof. Fowler an important paper to the Royal Society (Roy. Soc. Proc., Series A, vol. xc., No. A 622). The object of the research was first to obtain with the utmost accuracy the wave-lengths of the lines in the Balmer or series spectrum of hydrogen in order to test the formula and make such modifications of it as were considered necessary. Another part of the research restricted itself to the evaluation of the international system of wave-lengths of the constant occurring in the formula; the importance of this constant will be appreciated when it is stated that it may be used in all formulæ representing series of lines. The degree of accuracy which could be obtained with the spectrograph employed (10 ft. concave grating) using the new international standards of wave-length was next investigated. The results of the research are summed up as follows. The wave-lengths in I.A. of the first six lines of the hydrogen series were determined with an accuracy of about 0·001 Å.U. Balmer's formula was found to be inexact and the results could be represented by a modified Rydberg formula containing only two constants. An accuracy of 0·001 Å.U. was attainable in the third order of the grating spectrograph with exposures of less than half an hour. With longer exposures the determination became less accurate owing to the uncontrolled temperature of the instrument. The tertiary iron arc standards determined by Burns were tested in the special regions under investigation and found very satisfactory.

A NOVEL FORM OF ROWLAND GRATING MOUNTING.—Dr. A. S. King, in the Contributions from the Mount Wilson Observatory, No. 84 (*Astrophysical Journal*, vol. xl., 1914), describes a vertical adaptation of the Rowland mounting for a 15-ft. concave grating which has recently been mounted in the Pasadena laboratory of the Mount Wilson Solar Observatory. The general arrangement is as follows:—The plate-holder moves on a horizontal track, at a convenient distance above the floor, supported by a frame of channel iron placed over a slot in the cover of the pit used for the already existing vertical Littrow spectrograph. The slit is at one end of the horizontal track and vertically above the grating, and is contained in a hollow iron casting with a brass collar, which holds the slit tube and permits the adjustment of the height of the slit. The grating is contained in a cast-iron box with an extension which is bolted to the web of a girder connecting with the plate-holder carriage. The grating box is fixed to a carriage which is capable of movement on a vertical track, and an ingenious arrangement is adopted to allow for the variable pull when the grating is being raised by the movement of the plate-holder carriage along the horizontal track. Dr. King describes many interesting details about this variable counterweight system, the plate-holder carriage, photographic plate-holder, etc. While the mounting retains all the good features of the usual Rowland form, there are many distinct advantages. In the first place, there is an excellent temperature control in the pit, the grating and connecting girder benefiting thereby. The mounting requires little floor space, a narrow space against a wall being all that is necessary. No darkening of the room is necessary, and therefore no interference with other work being carried on in the laboratory. For assistance in planning the instrument Dr. King refers to Mr. Pease for designing the main structural features, to Mr. Nichols for numerous devices in convenience of working, and to Mr. Ayers and Mr. Shumway for construction and mounting.

THREE NEW INDIAN METEORITES.—At a meeting of the Asiatic Society of Bengal held on August 5 Mr. Coggin Brown read an interesting account of the fall of meteorites in India which had been described by Mr. C. A. Innes, the acting collector of Malabar. It seems that meteoric stones fell on April 6 last at Kuttayi, Triprangode, Trikanapuram, and Kuttippuram, places in the Pounani taluk of the Malabar district. These places are practically in a straight line, Kuttayi being on the coast and Kuttippuram nine or ten miles easterly from the last-mentioned place. Triprangode is about three miles from Kuttayi, Trikanapuram about five miles from Triprangode, and Kuttippuram about two miles from Trikanapuram. Four small stones are reported from Kuttayi, one from Triprangode, and six from Trikanapuram. One large stone, weighing 71 lb., fell at Kuttippuram, but it is now in three pieces. The account then describes the appearances of the fall at the different stations. As regards the large stone which fell at Kuttippuram, it is stated "the stone fell in a paddy field which was then dry and penetrated some feet into the ground. A cloud of dust rose into the air, and this cloud attracted people to the spot. But they were apparently afraid to touch the stone, and it was not until some hours later that it was dug out, and then it was quite cold. The people who gathered at the spot say that for some minutes after the fall there was a smell of backwater mud in the vicinity. Backwater mud or silt is black, oozy stuff, which is full of rotting organic matter, and its smell, which is familiar to everyone who lives in Malabar, is most unpleasant." The noise of the first two loud reports is said to have been heard at various places in Malabar. It was heard distinctly at Pounani, 4·5 miles from Kuttayi, and was recorded as having been heard at Calicut, a distance of thirty miles north of Kuttayi.

THE LANCASHIRE SEA FISHERIES LABORATORY.[1]

WE have recently received the report for 1913 on the Lancashire Sea Fisheries Laboratory at the University of Liverpool and the Sea Fish Hatchery at Piel, edited by the honorary director of the scientific work, Prof. W. A. Herdman, F.R.S.

It appears that more than one million plaice and twelve million flounders were hatched at Piel and committed to the sea. The usual course of instruction for fishermen was given, and nature-study evening classes were restarted on behalf of the Education Committee of Barrow, both with satisfactory results. In connection with the classes for fishermen, a new edition of the syllabus has been published and brought up to date by Dr. Johnstone, while a section on navigation by Captain Thornber has been included. There is also appended an excellent series of biological photographs by Mr. A. Scott.

Various observations arising out of mackerel investigations by Mr. Scott are given, particularly with regard to the food of the mackerel, and also a report on the distribution and periods of occurrence of pelagic fish eggs. The seventh annual survey of the work on the intensive study of Irish Sea plankton is submitted by the director, together with some observations on the summer plankton of the west coast of Scotland. The records of the work done by Dr. Johnstone in connection with diseases of fishes are incorporated, as is also a continuation of his detailed work on the measurements of plaice, the latter being of particular interest in view of the proposal by the International Fisheries Bureau to impose limits on

[1] Report on the Lancashire Sea Fisheries Laboratory for 1913. No. xxii.

the size of plaice to be landed. The results of Dr. Johnstone's plaice-marking experiments are also given.

Mr. William Riddell continues his hydrographical investigations, and the results of the chemical analyses of the water samples and a dissertation on their import are given by Prof. Bassett. As part of a proposed general scheme of investigation of the British herring races arranged by the Board of Fisheries, several samples of herrings from the Welsh coast and from the Smalls were examined and the measurements are detailed in the report. A paper of a preliminary nature on sea-bottom deposits and fish food off the Lancashire and Cumberland coasts is contributed by Mr. R. Ray. Dr. Johnstone gives a topographical description of the mussel grounds in the Ribble Estuary and several other Welsh beds. From the results of a bacteriologial analysis, also given, much sewage contamination seems to exist at several of the grounds.

Two important papers by Prof. Moore and his collaborators are given on the debated question of the ability of marine animals to subsist on the organic carbon dissolved and in suspension in sea-water. The results seem to prove conclusively that such subsistence for long periods is impossible, and that neither dissolved organic matter nor the average amount of suspended plankton suffices to account for the nutrition of the larger marine organisms.

Several minor reports conclude the survey of the year's work.

THE METROPOLITAN WATER SUPPLY.[1]

THE two reports by Dr. A. C. Houston, director of water examination, recently issued by the Metropolitan Water Board, show how much is now being done to safeguard from contamination with dangerous micro-organisms the metropolitan water supply, which is admittedly largely derived from sewage-polluted sources. The eighth annual report gives the results of the chemical and bacteriological examination of the London waters for the twelve months ended March 31, 1914. In the introduction Dr. Houston points out that experience in the Water Board laboratories indicates that *Bacillus coli* is practically totally absent from pure waters; in ten specially devised experiments with the Twins well (Deptford) water, typical *B. coli* was absent from 10,000 c.c., and it has been abundantly shown that it is possible, at a not impracticable cost, so to purify the raw river waters that the final product contains no typical *B. coli* in 100 c.c. in more than 80 per cent. of the samples.

In the tenth report on research work, the results of several important researches are detailed. The search for the typhoid bacillus and similar micro-organisms in raw river water and crude sewage has been continued, but although a large number of samples has been examined, none has been found. Various methods for the isolation of the typhoid bacillus in these circumstances are reviewed.

A study of the streptococci present in excremental matters has not resulted in finding any definite difference between those present in human, and those present in animal, excrement.

The value of storage as a means of eliminating pathogenic micro-organisms and of lime as a bactericidal agent are further confirmed in series of new experiments.

[1] Metropolitan Water Board (*a*) "Eighth Annual Report" on the results of the Chemical and Bacteriological Examination of the London Waters for the twelve months ended March 31, 1914. (*b*) "Tenth Report on Research Work." Both by Dr. A. C. Houston, Director of Water Examination, Metropolitan Water Board.

Altogether these two reports are worthy of careful perusal by public health authorities and bacteriologists, and show how much valuable but unobtrusive work is being done by Dr Houston and his staff.

R. T. HEWLETT.

LOCAL CASE-HARDENING OF STEEL.[1]

IN a paper read to the Société d'Encouragement pour l'Industrie National, MM. Guillet and Bernard discuss the various methods employed when it is desired to case-harden steel objects in certain parts only. The methods used are:—

(1) The parts to be protected against cementation are covered with fire-clay. The protection thus furnished is not complete, as the gases penetrate the fire-clay. Also in complex shapes the method becomes complicated and expensive.

(2) A tube is shrunk over the parts to remain uncemented, the thickness of the tube being slightly greater than the depth of case required. After the end of the cementing process, the tube is broken off. This method is obviously very limited in its application.

(3) The object is made with extra thicknesses in those parts which must not be hardened. After cementation and before hardening, these extra thicknesses are machined off. This process is very expensive.

(4) The parts not to be cemented are protected by a metallic deposit which must be (*a*) solid at the cementing temperature, (*b*) impervious to the cementing materials, (*c*) easily obtained commercially, and (*d*) easily removed after the operation. Copper and nickel are the only metals which fulfil conditions (*a*) and (*c*), and the latter fails to comply with condition (*b*).

The metal may be deposited by immersion in a salt solution, by electrolysis, or by the Schoop spraying process. The first mentioned is not satisfactory owing to the thinness and uncertain adherence of the coating. The electrolytic process is cheaper to instal than the spray process, which, on the other hand, is quicker and more easily localised.

The authors also consider the question of diffusion of metals. They show that for this to take place, (1) the two metals must be capable of forming solid solutions with each other, (2) they must be in very good contact, and (3) the temperature must be between the limits at which the solid solution exists. The higher the temperature, the greater is the rate of diffusion. They conclude that the diffusion of solids into solids is a very common phenomenon, which in certain cases (*e.g.* tinned condenser tubes) may introduce very considerable changes into the properties of the metal.

[1] "Les réserves en cémentation et la diffusion dans les solides." By MM. Léon Guillet and Victor Bernard. *Bulletin de la Société d'Encouragement pour l'Industrie Nationale*, vol. cxxi, No. 5. Pp. 588–618.

THE AUSTRALIAN MEETING OF THE BRITISH ASSOCIATION.

SECTION K.

BOTANY.

OPENING ADDRESS BY PROF. F. O. BOWER, D.Sc., F.R.S., PRESIDENT OF THE SECTION.

To preside over the botanical section on the occasion of its first meeting in Australia is no slight honour, though it also imposes no small responsibility. We members from Great Britain have a deep sense of the advantage which we derive from visiting these distant shores. I am doubtful whether any scientific

profit we can confer by our coming here can balance that which we receive; while over and above this is the personal kindliness of the Australian welcome, which on behalf of the visitors of this section from the Old Country I take this opportunity of gratefully acknowledging. Of the members of the British Association, those who pursue the natural sciences may expect to gain most by their experiences here; and perhaps it is the botanists who stand to come off best of all. Living as most of us do in a country of old cultivation, the vegetation of which has been controlled, transformed, and from the natural floristic point of view almost ruined by the hand of man, it is with delight and expectation that we visit a land not yet spoilt. To those who study Ecology, that branch of the science which regards vegetation collectively as the natural resultant of its external circumstances, the antithesis will come home with special strength, and the opportunity now before them of seeing Nature in her pristine state will not, I am sure, be thrown away.

I may be allowed here to express to the Australian members of the section my regret that the presidency for this occasion should not have fallen to one who could with unusual weight and knowledge have addressed them from the floristic and geographical point of view. I mean, to Professor Bayley Balfour, of Edinburgh, who was actually invited by the Council to preside. He could have handled the subject of your rich and peculiar flora with detailed knowledge; and, with the true Hookerian touch, he would have pictured to you in bold outlines its relation to present problems. Failing such equipment, I may at least claim to have made some of your rare and peculiar forms the subject of special study at intervals spread over thirty years: for it was in 1884 that I was supplied with living plants of Phylloglossum by Baron Ferdinand von Müller, while a paper to be published this year contains details of a number of ferns kindly sent to me by various collectors from New Zealand. I have been personally interested more especially in your rare Pteridophytes, isolated survivals as they surely are of very ancient vegetation. I propose to indicate later in this address some points of interest which they present. But first I shall offer some more general remarks on the history of the investigation of the Australian flora, as a reminder of the recent death of Sir Joseph Hooker, whose work helped so greatly to promote a philosophical knowledge of the flora of this quarter of the globe.

Few, if any, of the large areas of the earth's surface have developed their coat of vegetation under such interesting conditions as that which bears the Australasian flora. In its comparative isolation, and in its freedom from the disturbing influence of man, it may be held as unique. We may picture to ourselves the field as having been open to evolutionary tendencies, unusually free from the incursion of competitive foreign types, and with its flora shaped and determined through long ages in the main by climatic influences. Naturally the controlling effect of animal life had been present throughout, as well as that of parasitic and fungal attack; but that potent artificial influence, the hand of man, was less effective here than in almost any other area. The aborigines were not tillers of the soil: in their digging for roots and such-like actions they might rank with the herbivorous animals, so far as they affected the vegetation. Probably the most powerful influence they exercised was through fire. And so the conditions remained, the native flora being practically untouched, until the visit of Captain Cook in 1770: for little account need be taken of the handful of specimens collected by Dampier in the seventeenth century.

Captain Cook shipped with him in the *Endeavour* a very remarkable man, viz., Joseph Banks, whom Dr. Maiden has described as "the Father of Australia." He not only acted as the scientific director of the expedition, but he was also its financier. Educated at Eton and Oxford, he found himself as a young man possessed of an ample fortune. Though devoted to field sports, he did not, like so many others, spend his life upon them. Following the dictates of a taste early awakened in him, he turned his attention to travel for scientific ends. His opportunity came when Cook was fitting out the *Endeavour* for his first voyage to the Southern Seas. Banks asked leave of the Admiralty to join the expedition, which was granted, and he furnished all the scientific stores and a staff of nine persons at his own expense.

The story of that great expedition of 1768 to 1771 is given in "Cook's Voyages," compiled by Dr. Hawkesworth, a book that may be found in every library. Though it is evident throughout that Banks took a leading part in the observational work of the expedition, it has not been generally known how deeply indebted Hawkesworth was to Banks for the scientific content of his story. This became apparent only on the publication of Banks's own Journal 125 years after the completion of the voyage. The circumstances of this have a local interest, so I may be excused for briefly relating them.

Banks's papers, including the MS. Journal, passed with his library and Herbarium on his death to his librarian, Robert Brown. On the death of the latter they remained in the British Museum. But after lying there for a long period they were claimed and removed by a member of Banks's family, and were put up for auction. The Journal was sold for 7*l.* 2*s.* 6*d.*, and the last that has been heard of it is that it came into the possession of a gentleman in Sydney. Perhaps it may be lying within a short distance of the spot where we are now met. This valuable record, fit to rank with Darwin's "Voyage of the *Beagle*," or Moseley's account of the "Voyage of the *Challenger*," might thus have been wholly lost to the public had it not been for the care of Dawson-Turner, who had the original transcribed by his daughters, helped by his grandson, Joseph Dalton Hooker. The boy was fascinated by it, and doubtless it helped to stimulate to like enterprises that botanist to whom Australia owes so much. The copy thus made remained in the British Museum. Finally, from it in 1896 Sir Joseph Hooker himself edited the Journal, in a slightly abridged form. It is now apparent how very large a share Banks actually took in the observation and recording, and how deeply indebted to him was the compiler of the account of the voyage published more than a century earlier, not only for facts, but even for lengthy excerpts.

The plants collected in Australia by this expedition amounted to some 1000 species, and with Banks's Herbarium they found, after his death, a home in the British Museum. Several minor collections were subsequently made in Australia, but the next expedition of prime importance was that of Flinders in 1801 to 1805. What made it botanically notable was the presence of Robert Brown. Hooker speaks of this voyage as being, "as far as botany is concerned, the most important in its results ever taken." The collections came from areas so widely apart as King George's Sound, Southern Tasmania, and the Gulf of Carpentaria. These together with Banks's plants and other minor collections, formed the foundation for Brown's "Prodromus Floræ Novæ Hollandiæ," a work which was described in 1860 by Sir Joseph Hooker as being "though a fragment . . . the greatest botanical work that has ever appeared." It

was published in 1810. I must pass over without detailed remark the notable pioneer work of Allan Cunningham, and of some others. The next outstanding fact in the history of Australian botany was the voyage of Ross, with the *Erebus* and the *Terror*; for with him was Joseph Hooker, whose botanical work gave an added distinction to an otherwise remarkable expedition.

The prime object of the voyage was a magnetic survey, and this determined its course. But in the intervals of sailing the Antarctic Seas the two ships visited Ascension Island, St. Helena, the Cape, New Zealand, Australia, Tasmania, Kerguelen Island, Tierra del Fuego, and the Falkland Islands. Thus Hooker had the opportunity of collecting and observing upon all the great circumpolar areas of the Southern Hemisphere. He welded together the results results into his great work "The Antarctic Flora." It was published in six large quarto volumes. In them about 3000 species are described, while on 530 plates 1095 species are depicted, usually with detailed analytical drawings. But these magnificent volumes did not merely contain reports of explorations, or descriptions of the many new species collected. There was much more than this in them. All the known facts that could be gathered were incorporated, so that they became systematically elaborated and complete floras of the several countries. Moreover, in the last of them, the "Flora Tasmaniæ," there is an introductory essay, in which the Australasian flora was for the first time treated as a whole, and its probable origin and its relation to other floras discussed. Further, questions of the mutability and origin of species were also raised in it. The air was full of such questions in 1859; the essay was completed in November of that year, less than twelve months after the joint communications of Darwin and Wallace had been made to the Linnean Society, and before the "Origin of Species" was published. It was to this essay that Darwin referred when he wrote that "Hooker has come round, and will publish his belief soon." But this publication of his belief in the mutability of species was not merely an echo of assent to Darwin's own opinion. It was a reasoned statement advanced upon the basis of his own "self-thought," and his own wide systematic and geographical experience From these sources he drew support for "the hypothesis that species are derivative and mutable." He points out how the natural history of Australia seemed specially suited to test such a theory, on account of the comparative uniformity of the physical features being accompanied by a great variety in its flora, and the peculiarity of both its fauna and flora, as compared with other countries. After the test had been made on the basis of the study of some 8000 species of plants, their characters, their spread, and their relations to those of other lands, Hooker concluded decisively in favour of mutability, and a doctrine of progression. After reading this essay, Darwin wrote that it was to his judgment "by far the grandest and most interesting essay on subjects of the nature discussed I have ever read."

But beyond its historical interest in relation to the "Origin of Species," Hooker's essay contained what was up to its time the most scientific treatment of a large area from the point of view of the plant-geographer. He found that the Antarctic, like the Arctic flora, is very uniform round the globe. The same species in many cases occur on every island, though thousands of miles of ocean may intervene. Many of these species reappear in the mountains of Southern Chili, Australia, Tasmania, and New Zealand. The southern temperate floras, on the other hand, of South America, South Africa, Australia, and New Zealand differ more among themselves than do the floras of Europe, Northern Asia, and North America. To explain these facts Hooker suggested the probable former existence, during a warmer period than the present, of a centre of creation of new species in the Southern Ocean, in the form of either a continent or archipelago, from which the Antarctic flora radiated. From the zoological side a similar difficulty arises, and the hypothesis of a land-connection has been widely upheld, and that it existed as late as Mid-Tertiary times. The theory took a more definite form in the hands of Osborn (1900), who pictured relatively narrow strips of land connecting respectively South America on one side and Tasmania and New Zealand on the other with the existing Antarctic land area. This would accord well enough with the suggestion of Lothian Green, that the plan of land-elevations on the earth is approximately tetrahedral; and it is, I believe, in line with the views of those who are best informed on Antarctic geography and geology, as studied from the land itself. It may be hoped that further Antarctic discovery may bring fresh facts to bear upon this question, for it is to the positive data acquired from study of the earth's crust that we must look, rather than to the exigencies of botanists and zoologists, for its final solution.

But the hypothesis of an Antarctic land-connection has been held open to doubt in various quarters. As Sir Wm. Thistleton-Dyer has recently pointed out, Darwin himself dissented, though regretfully, from the sinking of imaginary continents in a quite reckless manner, and from the construction of land-bridges in every convenient direction. From the geological side Dana laid down the positive proposition that the continents and oceans had their general outline and form defined in earliest time. Sir John Murray, whose recent death we so deeply deplore, was an undeniable authority as to the ocean-floor. He wrote quite recently with regard to Gondwana-land, that "the study of ocean-depths and ocean-deposits does not seem in any way to support the view that continental land has disappeared beneath the floor of the ocean in the manner indicated." He suggested that the present distribution of organisms is better interpreted by the North Polar theory of origin. The "continuous current of vegetation" southward at the present time was recognised by Hooker himself, and definite streams of northern forms have been traced by him extending even to Australia and Tasmania. This might account for much in present-day distribution; though it seems doubtful whether it would fully explain the extraordinary distribution of Antarctic plants. The problem must for the present remain open.

This whole question, however, has a connection with the still wider difficulty of the existence within the Polar area of ancient floras. In the north the fossils are even of subtropical character. Coal has been found in lands with a five months' night. How did such plants fare if the seasonal conditions were at all like the present? To explain this it would be a physiological necessity to assume either an entirely different climatal condition in those regions from that of the present time; or, as has been suggested, some shifting or creeping of the earth's crust itself. These are, however, questions which we cannot undertake to discuss with effect in the Botanical Section. We must not do more than recognise that an unsolved difficulty exists.

We pass now from Hooker's great work to the last of the classical series, viz. the "Flora Australiensis" of Bentham and Baron Ferdinand von Müller. It is

embodied in seven volumes, and was completed in 1878. Bentham, while assenting in his "concluding preface" to the principles laid down by Hooker in the Tasmanian flora, recognised as the chief component part of the present flora of Australia the indigenous genera and species, originated or differentiated in Australia, which never spread far out of it. Secondly, an Indo-Australian flora showing an ancient connection between Australia and the lands lying to the north. It is represented especially in tropical and subtropical East Queensland. Then there is the mountain flora common to New Zealand, and extending generally to the southern extratropical and mountain regions, while other constituents are ubiquitous maritime plants, and those which have been introduced since the European colonisation. But the most remarkable, as they are the least easily explained, are some few plants identical with species from North and West America, and from the Mediterranean. They are stated to be chiefly annuals, or herbaceous or shrubby plants; free-seeders; while their seeds long retain the power of germination. This may perhaps give the clue to this curious conundrum of distribution.

It has been fortunate that the duty of working out this remarkable flora should have fallen into the hands of such masters as Robert Brown, Sir Joseph Hooker, and Bentham. The foundations were thus surely laid. The further progress of knowledge has been carried on by the late Baron Ferdinand von Müller, and it may be confidently left in the hands of others who are still with us. The completion of the task of observing and recording may still be far ahead. But I may be pardoned if I utter a word of anticipatory warning. There is at the present time a risk that the mere work of tabulating and defining the species in a given country may be regarded as the only duty of a Government botanist; that, whenever this is completed, his occupation will be gone. Some such erroneous idea, together with a short-sighted economy, is the probable explanation of the fact that certain positions hitherto held by professional botanists have recently been converted into positions to be held by agriculturists. In the countries where this has happened (and I refer to no part of Australasia) the vegetation had been very adequately, though not yet exhaustively, worked, as regards the flowering plants and ferns. But who that knows anything about plants would imagine that the ascription to a genus or order, or the designation by a couple of Latin names with a brief specific description, exhausts what it is important to know about a species? In most cases it is after this has been done that the real importance of its study begins. Such possibilities as these do not appear to have been appreciated by those who advised or controlled these official changes. I have no desire to undervalue the agriculturist or the important work which he does. But he is engaged in the special application of various pure sciences, rather than in pure science itself. Advance in the prosperity of any country which has progressed beyond the initial stages of settlement follows on the advance of such knowledge as the devotee of pure science not only creates, but is also able to inculcate in his pupils. It is then imperative that, in any State which actively progresses, provision shall be made for the pursuit of pure as well as of applied science. In my view an essential mistake has been made in changing the character of the appointments in question from that of botanists to that of agriculturists. For the change marks the abandonment of pure science in favour of its specialised and local application.

The head of such an institution should always be a representative of pure science, thoroughly versed in the nascent developments of his subject. He could then delegate to specialists the work of following out in detail such various lines of special application as agriculture, acclimatisation, plant-breeding, forestry, or economics. Or, if the organisation were a large one, as we may anticipate that it would become in the capital of a great State, separate institutes might develop to serve the several applied branches, while to a central institute, in touch with them all, might be reserved the duty of advancing the pure science from which all should draw assistance and inspiration.

It matters little how this principle works out in detail, if only the principle itself be accepted, viz., that pure science is the fount from which the practical applications spring. Sydney, as the capital of a great State, has already laid her course, as regards botanical science, in accordance with it. Her Botanic Garden and the recently developed Botanical Department in the University (which, I understand, may find its home ultimately in the Botanic Garden) will serve as centres of study of the pure science of botany. This will readily find its application to agriculture, to forestry, to economics, and in various other lines present and future. I am convinced that it is in the best interest of any State that can possibly afford to do so to encourage and endow liberally the central establishment where the pure science of botany is pursued, and to continue that encouragement and endowment, even though results of immediate practical use do not appear to be flowing from it at any given moment. For in these matters it is impossible to forecast what will and what will not be eventually of practical use. And in any case as educational centres the purely botanical establishments will always retain their important function of supplying that exact instruction, without which none can pursue with full effect a calling in the applied branches.

We may now turn from generalities to certain points of interests in your peculiar flora which happen to have engaged my personal attention. They centre round a few rare and isolated plants belonging to the Pteridophyta, a division of the vegetable kingdom which there is every reason to believe to have appeared relatively early in the history of evolution. But though the type may be an ancient one, it does not follow that every representative of it preserves the pristine features intact. Throughout the ages members of these early families may themselves have progressed. And so among them to-day we may expect to find some which preserve the ancient characters more fully than others. The former have stood still, and may be found to compare with curious exactitude with fossils even of very early date. The latter have advanced, and though still belonging to the ancient family, are by their modifications become essentially modern representatives of it. For instance, the fern Angiopteris has a sorus which very exactly matches sori from the Palæozoic period, and it may accordingly be held to be a very ancient type of fern. On the other hand, the genera Asplenium, or Polypodium, include ferns of a type which has not been recognised from early fossil-bearing rocks, and they may be held to be essentially modern. But still all of them clearly belong to the family of the Ferns.

In the Australian flora only three of the four divisions of the Pteridophyta are represented. For, curiously enough, there does not appear to be any species on your continent of the widely spread genus Equisetum, the only living genus of that great phylum of the Equisetales, which figured so largely in the Palæozoic period; and this notwithstanding that one species (*E. debile*) is present among the Polynesian Islands. But all the three other divisions of the Pteridophyta are included, and are represented in each case by plants which show peculiar and probably for the most

part archaic characters. I propose to sketch before you very briefly the points of interest which the more notable of these archaic types present. Some justification may be found for my doing so because nearly all of them have been submitted to detailed study in my laboratory in Glasgow, and much of the work has been done upon material supplied to me by your own botanists. I take this opportunity of offering to them collectively my hearty thanks.

The tenure by Dr. Treub of the office of director of the Botanic Gardens of Buitenzorg, was rendered famous by his personal investigations, and chiefly by his classical researches on the Lycopods. These were followed up by other workers, and notably by Bruchmann; so that we now possess a reasonable basis for comparison of the different types of the family as regards the prothallus and embryology, as well as of the sporophyte plant; and all these characters must be brought together as a basis for a sound conclusion as to their phyletic seriation. The most peculiar living Lycopods are certainly Isoëtes and Phylloglossum, both of which are found in Australia. The former need not be specially discussed here, as it is a practically world-wide genus. It must suffice to say that it is probably the nearest living thing to the fossils Lepidodendron and Sigillaria, and may be described as consisting of an abbreviated and partially differentiated Lepidostrobus seated upon a contracted stigmarian base.

But Phylloglossum, which is peculiar to the Australasian region, naturally claims special attention. The plant is well known to botanists as regards its external features, its annual storage tuber, its leafy shoot with protophylls and roots, and its simple shaft bearing the short strobilus of characteristic Lycopod type. But its prothallus has never been properly delineated, though it was verbally described by Dr. A. P. W. Thomas in 1901 (Proc. Roy. Soc., vol. lxix., p. 285). Perhaps the completed statement may have been reserved as a pleasant surprise for this meeting. But the description of thirteen years ago clearly shows its similarity to the type of *Lycopodium cernuum*. The sporophyte compares rather with *L. inundatum*. Both of these are species which, though probably not the most primitive of the genus, are far from being the most advanced. As all botanists know, the question of the position of Phylloglossum chiefly turns upon the view we take of the annual tuber and its protophylls. Treub, finding similar conditions in certain embryos of Lycopods, called it a "protocorm," and believed that he recognised in it an organ of archaic nature, which had played an important part in the early establishment of the sporophyte in the soil, physiologically independent of the prothallus. I must not trouble you here with the whole argument in regard to this view. Facts which profoundly affect the conclusion are those showing the inconstancy of occurrence of the organ. Mr. Holloway has recently described it as of unusual size in your native *L. laterale*, as it is also in *L. cernuum*. But it is virtually absent in those species which have a large intraprothallial foot, such as *L. clavatum*, as well as in the genus Selaginella and in Isoëtes. In *L. selago*, which on other grounds appears to be primitive, there is no "protocorm." Such facts appear to me to indicate caution. They suggest that the "protocorm" is an opportunist local swelling of inconstant occurrence, which, though biologically important in some cases, is not really primitive.

If this is the comparative conclusion, then our view will be that Phylloglossum is a type of Lycopod which has assumed, perhaps relatively recently, a very practical mode of annual growth. Related, as it appears to be on other points, with the *L. inundatum* group of species, it has bettered their mode of life. *L. inundatum* dies off each year to the very tip of its shoot, so that only the bud remains to the following season. It is notable that Goebel has described long ago how the young adventitious buds of this species start with small "protocorms," quite like those of Phylloglossum itself, or like the embryo of *L. cernuum*. And so we may conclude that in Phylloglossum a tuberous development, containing a store to start the plant in the spring, has been added to what is already seen normally each year in *L. inundatum*. And this mode of life of Phylloglossum begins, as Thomas has shown, with its embryo. This appears to me to be a rational explanation of the "protocorm" of Phylloglossum; but it robs the plant of much of its theoretical interest as an archaic form.

The phylum of the Sphenophyllales was originally based on certain slender straggling plants of the genus Sphenophyllum found in the Palæozoic Rocks; but they apparently died out in the Permian period. Your native genera, Tmesipteris and Psilatum, were ranked by earlier botanists with the Lycopods, but a better acquaintance with their details, and especially the examination of numerous specimens on the spot, indicated a nearer affinity for them with the Sphenophyllales. It was Prof. Thomas who in 1902 first suggested that the Psilotaceæ might be included with the Sphenophyllæ in the phylum of the Sphenophyllales, and I personally agree with him. Dr. Scott, however, dissents, on the ground that the leaves are persistently whorled in the sphenophylls, while they are alternate in the Psilotaceæ; and while the former branch monopodially the latter dichotomise. But since both these characters are seen to be variable within the not far distant genus Lycopodium, the differences do not seem to me to be a sufficient ground for keeping them apart as the separate phyla of Sphenophyllales and Psilotales. Whatever degree of actual relation we trace, such plants as Tmesipteris and Psilotum are certainly the nearest living representatives of the Sphenophylleæ, a fact which gives them a special distinction. The Psilotaceæ also stand alone in the fact that they are the only family of the Pteridophytes in which the gametophyte is still unknown. They produce spores freely, but there the story stops. Any young Australian who hits upon the way to induce these recalcitrant spores to germinate, and to produce prothalli and embryos, or who found their prothalli and embryos in the open, would have before him a piece of work as sensational as anything that could be suggested. Further, I am told that Tmesipteris grows here on the matted stumps of *Todea barbara*. I shall be alluding shortly to the fossil Osmundaceæ. May we not venture to fancy the possibility of some fossil Osmunda being found which has embalmed for us among its roots a Mesozoic or even a Tertiary Sphenophyll? And thus a link might be found between the Palæozoic types and the modern Psilotaceæ, not only in time, but even in character.

We pass now to the last phylum of the Pteridophyta, the Filicales. I am bound to say that for me its interest far outweighs that of the others, and for this reason: that it is represented by far the largest number of genera and species at the present day, while there is a sufficiently continuous and rich succession of fossil forms to serve as an efficient check upon our comparative conclusions.

Since 1890 it has been generally accepted that the Eusporangiate ferns (those with more bulky sporangia) were phyletically the more primitive types, and the Leptosporangiate (those with more delicate sporangia) the derivative, and in point of time later. The fossil evidence clearly upholds this conclusion. But, further, it has been shown that the character of the sporangium is merely an indicator of the general constitution of the plants in question. Where it is large and complex, as in the Eusporangiates, all the apical seg-

mentations are, as a rule, complex, and the construction of the whole plant relatively bulky. Where the sporangium is delicate and relatively simple all the apical segmentations follow suit, and the construction of the plant is on a less bulky model. On this basis we may range the ferns roughly as a sequence, starting from relatively bulky types of the distant past, and progressing to the more delicate types of the present day. The large majority of the living species belong naturally to the latter. But the former are still represented by a few genera and species which, like other survivals from a distant past, are frequently of very restricted distribution.

An interesting feature of the Australasian flora is that a considerable number of these relatively ancient forms are included in it. Thus the Marattiaceæ are represented by one species of Marattia and one of Angiopteris. Though in themselves interesting, they will be passed over without special remark, as they are very widely spread tropical forms.

All the three genera of Ophioglossaceæ are included, there being two species of Ophioglossum and two of Botrychium, while Helminthostachys is recorded from Rockingham Bay. This family is coming more than ever to the front in our comparisons, owing to their similarity in various aspects to the ancient Botryopterideæ. Though the Ophioglossaceæ have no secure or consecutive fossil history, still they may now be accepted as being very primitive but curiously specialised ferns. Perhaps the most interesting point recently detected in them is the suspensor found by Dr. Lyon in *Botrychium obliquum*, and by Dr. Lang in Helminthostachys. This provides a point for their comparison with the similar embryonic condition in Dancæa, as demonstrated by Prof. Campbell. The existence of a filamentous initial stage of the embryo is thus shown for three of the most primitive of living ferns. Its existence in all of the Bryophytes, and in most of the Lycopods, as well as in the seed-plants, is a very significant fact. Dr. Lang suggests that "the suspensor represents the last trace of the filamentous juvenile stage in the development of the plant, and may have persisted in the seed-plants from their filicineous ancestry." Such a possibility would fit singularly well with the theory of encapsulation of the sporophyte in the venter of the archegonium.

The representation of the ancient family of the Osmundaceæ in the Australasian flora is very fine, though limited to five living species, while Osmunda itself is absent. It is, however, interesting that the family dates back locally to early fossil times. It was upon two specimens of Osmundites from the Jurassic Rocks in the Otago district of New Zealand that the series of remarkable papers on the fossil Osmundaceæ by Kidston and Gwynne-Vaughan was initiated. It is no exaggeration to say that these papers have done more than any other recent researches to promote a true understanding, not only of the Osmundaceæ themselves, but of fern-anatomy as a whole. They have placed the stellar theory in ferns for the first time upon a basis of comparison, checked by reference to stratigraphical sequence. It would be leading us too far for me to attempt here to summarise the important results which have sprung from the study of those fossils, so generously placed by Mr. Dunlop in the hands of those exceptionally able to turn them to account. It must suffice to say that it is now possible to trace as a fairly continuous story the steps leading from the protostelic state to the complex condition of the modern Osmunda. These facts and conclusions are to be put in relation with the anatomical data fast accumulating from the Ophioglossaceæ in the hands of Prof. Lang and others. From such comparisons a rational explanation of the evolutionary steps leading to the complex stelar state in ferns at large begins to emerge. This is no mere tissue of surmises, for the conclusions are based on detailed comparison of types occurring in lower horizons with those of the present day.

I must pass over with merely nominal mention your interesting representation of the ancient families of Schizæaceæ, Gleicheniaceæ, and Hymenophyllaceæ, all of which touch the very foundations of any phyletic system of ferns. Also the magnificent array of Dicksonieæ and Cyatheæ, and of the important genus Lindsaya—ferns which take a rather higher position in point of view of descent. But I am bound to devote a few moments to one of your most remarkable ferns, endemic in New Zealand—the monotypic Loxsoma.

This species has peculiar characters which justify its being regarded systematically as the sole representative of a distinct tribe. It is also restricted geographically to the North Island of New Zealand. These facts at once suggest that it is an ancient survival, a conclusion with which its solenostelic axis, its sorus and sporangium, and its prothallus readily accord. I have lately shown that the Leptosporangiate ferns fall into two distinct series, those in which the origin of the sorus is constantly superficial, and those in which it is as constantly marginal. Loxsoma is one of the "Marginales." It shares this position with the Schizæaceæ, Thyrsopterideæ, Hymenophyllaceæ, and Dicksonieæ, and the derivatives Davallieæ and Oleandreæ. Its nearest living relative is probably Thyrsopteris, which is again a monotypic species endemic in the island of Juan Fernandez. There is also a probable relation to the genus Loxsomopsis, represented by one species from Costa Rica, and a second lately discovered in Bolivia. Such a wide and isolated distribution of types, which by their characters are certainly archaic, suggests that we see in them the relics of a filicineous state once widely spread, which probably sprang from a Schizæaceous source and with them represent the forerunners of the whole marginal series. If we look for further enlightenment from the fossils, it is to the Secondary rocks that we should turn. It is then specially interesting that Mr. Hamshaw Thomas has lately described a new Jurassic fern, *Stachypteris halli*, which has marginal sori, and is probably referable to a position like that of Loxsoma and Thyrsopteris, between the Schizæaceæ and the Dicksonieæ. In fact, the gaps in the evolutionary series of the Marginales are filling up. We may await with confidence fresh evidence from the Jurassic period, upon which Prof. Seward is directing an intensive interest.

I should be ungrateful indeed if I did not mention your very full representation of Blechnoid ferns: for developmental material of several of these has been sent to me by Dr. Cockayne, and others from New Zealand. A wide comparative study of the genus has led me to somewhat unexpected results in regard to the plasticity of the sorus, its phyletic fusions and disruptions. The consequent derivative forms are seen in Woodwardia and Doodya on one hand, and on the other in Scolopendrium and Asplenum. These ferns together constitute a coherent phylum springing ultimately from a Cyatheoid source. The details upon which this conclusion is based I hope to describe in a separate communication to the section.

And, lastly, the Hydropterideæ deserve brief mention. Represented in your flora by two species of Azolla, and one each of Marsilea and Pilularia, they typify a condition which must theoretically have existed among ferns in very early times, viz., the heterosporous state. But hitherto, notwithstanding the existence of our living Hydropterideæ, no fossil fern with microscopic structure preserved had been detected from the primary rocks, showing this intermediate condition between the homosporous type and that of

the pteridosperms. This unsatisfactory position has now been resolved by Professor Lignier, who has recently described, under the name of Mittagia, a fossil from the Lower Westphalian, which bore sori of which the sporangia contained four megaspores, while the outer tissues of the sporangia resembled those of Lagenostoma. Pending the discovery of further specimens, these observations may be welcomed as filling with all probability a conspicuous gap in the evolutionary sequence of known forms.

From the rapid survey which I have been able to give you of some of the more notable Australasian ferns of relatively archaic type, it is clear that they have a very interesting and direct bearing upon the phylesis of ferns. The basis upon which conclusions as to phyletic sequence are arrived at is at root that of the natural system of classification generally—the recognition, not of one character, or of two, but of as many as possible, which shall collectively serve as criteria of comparison. In the case of the Filicales we may use the characters of :—

(i) External form.
(ii) Constitution, as shown by simple or complex segmentation.
(iii) Dermal appendages, hairs or scales.
(iv) Stelar structure, simple or complex.
(v) Leaf-trace, coherent or divided.
(vi) Soral position.
(vii) Soral construction.
(viii) Indusial protections.
(ix) Sporangial structure, and mechanism of dehiscence.
(x) Spore-output.
(xi) Spore-form, and character of wall.
(xii) Form of prothallus.
(xiii) Position of the sexual organs, sunken or superficial.
(xiv) Number of spermatocytes, and method of dehiscence.
(xv) Embryology.

In respect of all these criteria progressions of character may be traced as illustrated by known ferns, and probably other criteria may emerge as study progresses. In each case, upon a footing of general comparison, checked as opportunity offers by reference to the stratigraphical sequence of the fossils, it may be possible to distinguish with some degree of certainty what is relatively primitive from what is relatively advanced. Thus, the protostele is generally admitted to be more primitive than the dictyostele, the simple hair than the flattened scale, and a high spore-output than a low one.

Applying the conclusions thus arrived at in respect of the several criteria, it becomes possible upon the sum of them to lay out the species and genera of ferns themselves in series, from the primitive to the advanced. In proportion as the progressions on the basis of the several criteria run parallel, we derive increased assurance of the rectitude of the phyletic sequences thus traced, which may finally be clinched, as opportunity offers, by reference to the stratigraphical occurrence of the corresponding fossils. This is in brief the phyletic method, as it may be applied to ferns. It may with suitable variation be applied to any large group of organisms, though it is seldom that the opportunities for such observation and argument are in any sense commensurate with the requirements. Perhaps there is no group of plants in which the opportunities are at the moment so great as in the Filicales, and they are yielding highly probable results from its application.

The greatest obstacle to success is found in the prevalence of parallel development in phyla which are believed to have been of distinct origin. This is exemplified very freely in the ferns, and the systematist has frequently been taken in by the resemblances which result from it. He has grouped the plants which show certain common characters together as members of a single genus. Sir William Hooker in doing this merged many genera of earlier writers. His avowed object was not so much to secure natural affinity in his system as readiness of identification : and consequently in the "Synopsis Filicum" there are nominal genera which are not genera in the phyletic sense at all. For instance, Polypodium and Acrostichum, as there defined, may be held from a phyletic point of view to be collective groupings of all such ferns as have attained a certain state of development of their sorus; and that they are not true genera in the sense of being associated by any kinship of descent : this is shown by the collective characters of the plants as a whole. Already at least four different phyletic sources of the Acrostichoid condition have been recognised, and probably the sources of the Polypodioid condition are no fewer. Such "genera" represent the results of a phyletic drift, which may have affected similarly a plurality of lines of descent. It will be the province of the systematist who aims at a true grouping according to descent to comb out these aggregations of species into their true relationships. This is to be done by the use of wider, and it may be quite new, criteria of comparison. Advances are being made in this direction, but we are only as yet at the beginning of the construction of a true phyletic grouping of the Filicales. The more primitive lines are becoming clearer : but the difficulty will be greatest with the distal branches of the tree. For these represent essentially the modern forms, they comprise the largest number of apparently similar species, and in them parallel development has been most prevalent.

If this difficulty be found in such a group as the Filicales, in which the earlier steps are so clearly indicated by the related fossils, what are we to say for the Angiosperms? Our knowledge of their fossil progenitors is very fragmentary. But they are represented now by a multitude of forms, showing in most of their features an irritating sameness. For instance, vascular anatomy, that great resource of phyletic study in the more primitive types, has sunk in the Angiosperms to something like a dead level of uniformity. There is little variety found in the contents of embryo-sacs, in the details of fertilisation, or in embryology. Even the ontogeny as shown in the seedling stages affords little consolation to the seeker after recapitulation. On the other hand, within what are clearly natural circles of affinity there is evidence of an extraordinary readiness of adaptability in form and structure. Such conditions suggest that we see on one hand the far-reaching results of parallel development, and on the other the effects of great plasticity at the present day, or in relatively recent times. Both of these are points which prevent the ready tracing of phyletic lines. In the absence of trustworthy suggestions from palæontology, the natural consequence is the current state of uncertainty as to the phyletic relations of the Angiosperms.

Various attempts have been or are being made to meet the difficulty. Some, on the basis of the recent observations of Wieland and others, are attempting along more or less definite monophyletic lines to construct, rather by forcible deduction than by any scientific method of induction, an evolutionary story of the Angiosperms. I do not anticipate that any great measure of success, beyond what is shown in a very polysyllabic terminology, and an appearance of knowing more than the facts can quite justify, will attend such efforts. It would seem to me to be more in accord with the dictates of true science to proceed

in a different way, as indeed many workers have already been doing. To start, not from preconceptions based upon limited palæontological data, but from an intensive study of the living plants themselves. To widen so far as possible the criteria of comparison, by making, for instance, every possible use of cellular, physiologico-chemical, and especially secretory detail, and of minor formal features, such as the dermal appendages, or by initiating a new developmental morphology of the flower from the point of view of its function as a whole: and with its physiological end clearly in sight, viz. the maturing, nourishing, and placing of new germs. To make on some such basis intra-ordinal, and intra-generic comparisons with a view to the phyletic seriation of closely related forms; and so to construct probable short series, which may subsequently be associated into larger phyletic groupings. This should be checked wherever possible by physiological probability. A keen eye should be kept upon such information as geographical distribution and palæontology may afford, and especially upon the fossils of the Mesozoic period. What is above all needed for success among the Angiosperms is new criteria of comparison, to meet the far-reaching difficulties that follow from parallel development and recent adaptation. If some such methods be adopted, and strenuously pressed forward, the task should not appear hopeless, though it cannot be anything else than an arduous one.

I cannot conclude without some remark on the bearing of parallel or convergent development, so fully exemplified in the Filicales, upon the question of the genesis of new forms. Anyone who examines, from the point of view suggested in this address, the larger and well-represented divisions of the Vegetable Kingdom must be impressed with the extraordinary dead level of type to which their representatives have attained. In most of these divisions the phyletic history is obscured, partly by the absence of any consecutive palæontological record, but chiefly by the want of recognised criteria for their comparison. This is very prominently the case for the Mosses, and the Angiosperms.

But it may be doubted whether these large groups differ in any essential point, in respect of the genesis of their multitudinous similar forms, from the Filicales, in which the lines of descent are becoming clearer through additional knowledge. Suppose that we knew of no fossil Ferns; and that none of the early fern-types included under the term "Simplices" had survived in our living flora: and that the Filicales of our study consisted only of the 2500 living species of the old undivided genera of Polypodium, Asplenium, Aspidium, and Acrostichum. Then the phyletic problem of the Filicales would appear as obscure as does that of the Mosses, or of the Angiosperms of the present day. They would present, as these great groups now do, an apparent dead level of sameness in type, though the phyletic starting-points in each may have been several and distinct. There is every reason to suppose that in the phylesis of the Mosses or the Angiosperms also there has been a parallel, and even a convergent, development of the same nature as that which can be cogently traced in the Filicales: but that it is obscured by the obliteration of the early stages. Internal evidence from their comparative study fully justifies this conclusion. How, then, are we to regard this insistent problem of parallelism and convergence from the point of view of genetic study?

A belief in the "inheritance of acquired characters," or, as is sometimes expressed, "somatic inheritance," is at present out of fashion in some quarters. But though powerful voices may seem to have forced it for the moment into the background, I would take leave to point out that such inheritance has not been disproved. All that has been done, so far as I understand the position, is to show that the evidence hitherto advanced in support of it is insufficient for a positive demonstration. That is a very different thing from proving the negative. We hear of "fluctuating variations" as distinct from "mutations"; and it is asserted that the former are somatic, and are not inherited, while the latter are inherited. This may be held as a useful terminological distinction, in so far as it accentuates a difference in the heritable quality. But it leaves the question of the origin of these heritable "mutations" quite open. At the present moment I believe that actual knowledge on this point is very like a complete blank. Further, it leaves indefinite the relative extent and proportion of the "mutations." It is commonly held that mutations are considerable deviations from type I am not aware that there is any sufficient ground for such a view. It may probably have originated from the fact that the largest are most readily observed and recognised as reappearing in the offspring. But this is no justification for ignoring the possibility of all grades of size or importance of heritable deviations from type.

On the other hand, adaptation, with its consequence of parallel or even convergent development in distinct stocks, is an insistent problem. The real question is: What causes are at work to produce such results? They are usually set down to the selection of favourable divergences from type out of those produced at random. But the prevalence of parallelism and convergence suggests that those inheritable variations, which are now styled "mutations," are not produced at random. These facts enforce the question whether or not they are promoted and actually determined in their direction, or their number, or their quality, in some way, by the external conditions. Parallelism and convergence in phyletic lines which are certainly distinct impress the probability that they are. Until the contrary is proved it would, in my opinion, be wiser to entertain some such view as a working hypothesis than positively to deny it. Such a working hypothesis as this is not exactly the same as a "mnemic theory," though it is closely akin to it. It may perhaps be regarded as the morphologist's presentation, while the mnemic theory is rather that of the physiologist. But the underlying idea is the same, viz. that the impress of external circumstance cannot properly be ruled out in the genesis of inheritable characters, simply because up to the present date no definite case of inheritance of observable characters acquired in the individual lifetime has been demonstrated. Of course, I am aware that to many this is flat heresy. At this meeting of the Association it amounts almost to high treason. I plead guilty to this heresy, which may by any sudden turn of observation be transformed into the true faith. I share it in whole or in part with many botanists, with men who have lived their lives in the atmosphere of experiment and observation found in large botanic gardens, and not least with a former President of the British Association, viz. Sir Francis Darwin.

It is noteworthy how large a number of botanists dissent from any absolute negation of the influence of the environment upon the genesis of heritable characters. Partly this may be due to a sense of the want of cogency of the argument that the insufficiency of the positive evidence hitherto adduced justifies the full negative statement. But I think it finds its real origin in the fact that in plants the generative cells are not segregated early from the somatic. In this respect they differ widely from that early segregation

of germ-cells in the animal body, to which Weismann attached so much importance. The fact is that the constitution of the higher plants and of the higher animals is in this, as in many other points, radically different, and arguments from one to the other are dangerous in the extreme. Those who interest themselves in evolutionary questions do not, I think, sufficiently realise that the utmost that can be claimed is analogy between the higher terms of the two kingdoms. Their phyletic separation certainly dates from a period prior to that of which we have any knowledge from the fossil record. Let us give full weight to this fact, as important as it is indisputable. The early definition of germ-cells in the animal body will then count for nothing in the evolutionary problem of plants. Moreover, we shall realise that the plant, with its late segregation of germ-cells, will present the better field for the inquiry whether, and how far, the environment may influence or induce divergences from type. From this point of view the widespread opinion among botanists that the environment in some sense determines the origin and nature of divergences from type in plants should command a special interest and attention.

I must now draw to a close. I have passed in review some of your more notable plants, and pointed out how the Australasian flora, whether living or fossil, includes in unusual richness those evidences upon which the fabric of evolutionary history is being based. I have indicated how this history in certain groups is showing ever more and more evidence of parallel development, and that such development, or convergence, presses upon us the inquiry into the methods of evolutionary progress. The illustrations I have brought forward in this address clearly show how important is the positive knowledge derived from the fossils in checking or confirming our decisions. Palæophytology is to be prized not as a separate science, as, with an enthusiastic view restricted between blinkers, a recent writer has endeavoured to enforce. To treat it so would be to degrade it into a mere side alley of study, instead of holding it to be the most positive line that we possess in the broad avenue of botanical phylesis. An appreciation of such direct historical evidence is no new idea. Something of the same sort was felt by Shakespeare three centuries ago, and it remains the same to-day. Nay, more: it may lead us even to forecast future possibilities. In following our evolutionary quest in this spirit we shall find that we are indeed—

> "Figuring the nature of the times deceased
> The which observed, a man may prophesy
> With a near aim, of the main chance of things
> As yet not come to life."
>
> (King Henry IV., Part II, Act iii., Scene i.)

THE WIDMANSTATTEN STRUCTURE IN VARIOUS ALLOYS AND METALS.[1]

THE surface of meteoric iron after polishing and etching in the way usually adopted, prior to examination under the microscope, shows characteristic figures which are for the most part triangles or parallelograms. These figures were observed for the first time in 1808 by M. Alois de Widmanstätten, the director of the Imperial Porcelain Works at Vienna on the Ilraschina meteorite, and although Widmanstätten himself had published nothing regarding his discoveries, a knowledge of them spread very quickly, and what he had seen were soon universally known under the name of "Widmanstätten figures." It was

FIG. 1.—Widmanstätten Structure in Carbon Steel (Carbon 0·55 per cent.). Alloy No. 8. Magnified 8 diameters.

then generally considered that these figures were characteristic of meteoric iron and that they were not found in terrestrial iron. Guillet-Laumont[2] in 1813 already saw an analogy between the two varieties of iron; but the majority of investigators for a long time were of a different opinion, and the views of Guillet-Laumont were forgotten.

The interest in meteorites shown by Dr. Sorby, the founder of the science of metallography, and especially the brilliant researches of Osmond, led anew to attention being directed to the figures of Widmanstätten. Thus it was that in 1900 M. Osmond announced the discovery in the head of a steel ingot of equilateral triangles which recalled, he said, "the figures of Wid-

[1] Paper presented to the Institute of Metals for the September meeting by Capt. N. T. Belaiew (Michael Artillery Academy, Petrograd). Translated from the French of the original MS. of Capt. Belaiew, and, in consequence of the European War, not since revised by him.

[2] Cohen, *Meteoritenkunde*, 1894, vol. i., p. 41.

manstätten, which are known to belong to the regular octahedral system."[3]

In a previous paper[4] the author described a steel containing 0·55 per cent. of carbon, prepared in 1908 at the works of Igewsky in accordance with the directions of the author. This steel showed throughout its mass beautiful Widmanstätten figures, which were so developed that they were perfectly visible to the naked eye (Fig. 1). The analogy between the structure of the alloy and that of the meteorites was so close that the author considers that it may be regarded as a synthetic production of a meteoritic structure, and that it is fair to refer to this structure as the Widmanstätten structure (Figs. 2 and 3).

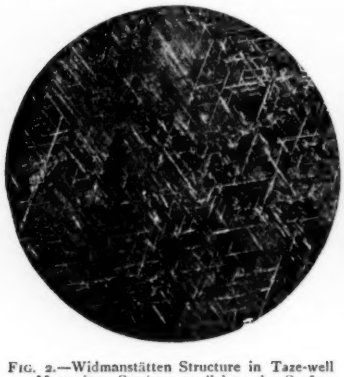

FIG. 2.—Widmanstätten Structure in Taze-well Meteorite. Section parallel to the Surface of the Octahedron. Magnified 6 diameters and slightly reduced.

FIG. 3.—Widmanstätten Structure in Carbon Steel (Carbon, 0·55 per cent.). Alloy No. 8. Magnified 9 diameters and slightly reduced.

FIG. 4.—Swedish Iron heated to the point of Incipient Fusion (Osmond, "Sur la Cristallographie du Fer"). Magnified 16 diameters.

Not only could the meteoritic structure be hence-

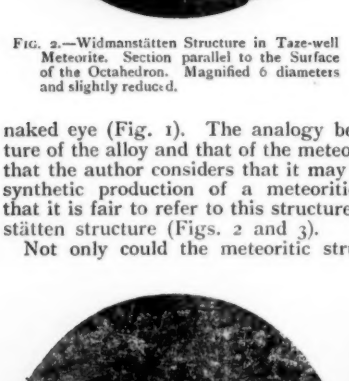

FIG. 5.—Widmanstätten Structure in Bronze, containing 55·1 per cent. Copper. Cooled in Sand and Annealed (L. Guillet, "Les Laitons au Nickel"). Magnified 30 diameters and slightly reduced.

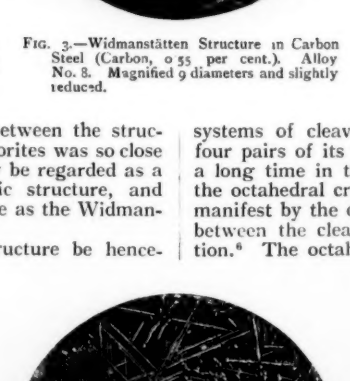

FIG. 6.—Widmanstätten Structure in Alloy of 90 per cent. Platinum and 10 per cent. Aluminium (Chouriguine, "Sur les alliages du Platine avec l'Aluminium"). Magnified 50 diameters and slightly reduced.

FIG. 7.—Widmanstätten Structure in Zinc, cast and cooled slowly (G. Timothéieff). Magnified (?) diameters and slightly reduced.

forth artificially reproduced at will, but the crystallisation of iron as well as its crystallography could be easily studied from such examples.

Although the question of the conditions which led to the appearance of this structure seemed extremely interesting, nevertheless it was considered wise to leave it on one side for the moment and to commence with what might be termed a more or less detailed "morphological" examination. From this it was not difficult to see that the character of the Widmanstätten figures changed several times in a given area, sometimes showing triangles, sometimes squares, but they are precisely the figures that would be expected in different sections of a regular octahedron the four systems of cleavages of which were parallel to the four pairs of its surfaces, an arrangement known for a long time in the case of meteorites.[5] Thus it was the octahedral crystallisation of iron which was made manifest by the distribution of the structural elements between the cleavage planes during the recrystallisation.[6] The octahedral crystallisation of alloys of iron is generally admitted,[7] and the greater part of the iron-carbon diagram belongs to the type of diagrams

[3] "Sur la Cristallographie du Fer," Paris, 1900, p. 24, figs. 24 and 25. The same observation was made in 1905 by Profs. Arnold and McWilliam in their memoir, "The Thermal Transformation of Carbon Steel," Journ. of the Iron and Steel Institute, 1905, No. II., p. 35.

[4] "Sur la reproduction artificielle de la structure de Widmanstätten dans ier au carbone," N. T. Belaiew, *Revue de Métallurgie*, 1910, p. 510.

[5] See Figs 7, 8, 9, 10, 11, 12, and 13, in the previously mentioned paper they are also reproduced in M. Sauveur's book, "The Metallography of Iron and Steel," Lesson x., figs. 7–13.

[6] "When a liquid or solid deposits successively several solid phases, the secondary and tertiary deposits often preferentially lodge between certain of the cleavage planes (plans cristallographiques) of the primary deposit, and thus illustrate its structure." "Sur la Cristallisation du Fer," Osmond et Cartaud, *Revue de Métallurgie*, 1906, p. 658.—*Note by* Editor, Proc. Inst. of Metals.

[7] See also "Sur la crystallisation et structure des aciers refroidis lentement," N. T. Belaiew, *Revue de Métallurgie*, 1912, p. 321.

in which there is recrystallisation in the solid state.

Following the brilliant theory of Osmond, the alloys of iron and of nickel in the case of meteorites ought to follow an analogous diagram.

Not long since this theory was entirely confirmed by the beautiful experiments of Benedicks. We see that in the two cases, in that of meteorites as well as in that of terrestrial iron, the appearance of these Widmanstätten figures is connected with two fundamental facts—the character of the primary octahedral crystallisation, and the separation of the solid solution into different phases during recrystallisation.

This structure, therefore, is not in the least confined to iron and its alloys; it might be equally well encountered in each alloy or each metal which crystallises in the regular system, and in which, after solidification, the crystallised solid solution throws out secondary deposits, that is to say, is subject to recrystallisation. In a pure metal there would be an allotropic change in the solid state, as, for example, the iron shown in Fig. 4—in an alloy, the separation of a new phase; and as diagrams of this kind are well known, it ought not to be at all difficult to find examples of the Widmanstätten structure in alloys other than iron.

To this class of alloys belong, for example, the different alloys of copper, particularly the brasses and bronzes. Gulliver, in his interesting volume on metallic alloys,[8] gives numerous examples of this, mentioning the separation of $SnCu_3$ in the alloys of copper and tin, of $SbCu_2$ in those of copper and antimony, of the constituent beta in brasses with about 35 per cent. of zinc (see Gulliver, Fig. 200), or of delta in the alloys with 70 to 75 per cent. of zinc (see Gulliver, Figs. 205 and 206). The author is able to reproduce here a photograph (Fig. 5) of a brass containing 55·1 per cent. of copper (cooled in sand and annealed), which was kindly sent to him by M. L. Guillet. This photograph has great interest, as it shows the action of reheating on the Widmanstätten structure.

Fig. 6 serves as another example of this structure, for which the author is indebted to M. Chouriguine; it represents an alloy of platinum-aluminium. M. Chouriguine,[9] in studying these alloys, found a transformation in the solid state, and this transformation manifested itself in a very marked Widmanstätten structure.

It is perhaps useful to remark that the first condition, that is to say, the primary octahedral crystallisation, is not difficult to find, for the majority of metals and alloys crystallise either in the regular or in the hexagonal system. In the last case the character of the Widmanstätten figures may differ in detail whilst preserving the same general aspect, as can be seen from Fig. 7,[10] representing a sample of zinc after melting and slow cooling.

These few examples, though taken somewhat haphazard, serve nevertheless as illustrations of the great extent to which the Widmanstätten structure exists in different alloys and metals. In the alloys of iron the Widmanstätten structure has an important industrial interest, as it gives rise to very poor mechanical properties in the case of cast steels and in overheated steels.

The chief object of this brief communication is to direct the attention of metallurgists and engineers to the study of alloys, other than iron, from the point of view of the production and the removal of the Widmanstätten structure.

[8] "Metallic Alloys," G. H. Gulliver.

[9] "Sur les alliages du platine avec l'aluminium," by M. Chouriguine. *Revue de Métallurgie*, 1912, p. 8735.

[10] This photograph was taken by M. Timothéieff.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

BELFAST.—Prof. R. H. Yapp has been appointed professor of botany in the Queen's University, Mr. C. W. Valentine professor of education, and Sir Hiram Shaw Wilkinson pro-Chancellor of the University.

GLASGOW.—Dr. W. J. Dilling, of Aberdeen, has been appointed to the new "Robert Pollok" lectureship, for research in materia medica and pharmacology, at the University of Glasgow.

The University Court has given leave of absence to Mr. A. Stevens, assistant in the department of geography, in order that he may accompany Sir Ernest Shackleton's Antarctic Expedition as geologist. The Court has also placed at his disposal a petrological microscopic equipment for the purposes of the expedition.

Temporary arrangement have been made for carrying on the work of a considerable number of the lecturers, assistants, and examiners, who, in consequence of the war, are absent on duty or detained abroad.

DR. D. A. CAMPBELL, of Halifax, has, says *Science*, promised 12,000*l.* to endow a chair of anatomy at Dalhousie University, Halifax, in memory of his son, the late Dr. George Campbell.

THE council of the Senate of the University of Cambridge has offered to professors, teachers, and students of the University of Louvain such facilities in the way of access to libraries, laboratories, and lectures, together with the use of lecture-rooms, as may secure the continuity of the work of that University during the present crisis. Hospitality in the way of living accommodation and so forth will probably be offered by the individual colleges and by private residents. The professors of the University of Oxford have offered a home for the winter to the young children of the professors of the University of Louvain; and the academic staff of University College (University of London) offers hospitality to about seventy members of French and Belgian universities, whether professors, teachers, or students, men or women, who may find it necessary to take refuge in this country.

A WELL illustrated prospectus for the present session of the Municipal Technical Institute, Belfast, has been issued. The chief object of the institute is to provide instruction in the principles of the arts and sciences which bear upon the trades and industries of Belfast, and to show by experiment how these principles may be applied to their advancement. The evening classes are designed for persons engaged during the day in handicrafts or business who desire to supplement and develop the knowledge and experience they have gained in the workshop and warehouse. It is satisfactory to notice that the prospectus insists that the successful prosecution of special studies is in proportion to the student's knowledge at the beginning of such work of the elements of mathematics and drawing. The day technical course provides instruction in the science and technology of mechanical and electrial engineering, the textile industries, and pure and applied chemistry; and it gives a sound training to youths who aim at filling responsible positions in these departments of activity. We notice that the Queen's University of Belfast and the Belfast Corporation have entered into an agreement whereby the institute is recognised as a college in which students of the University may study to qualify for a degree or diploma in science of the University. It is impossible in view of the completeness and multiplicity of the arrangements which have been made to meet the needs of every class of student, to mention them all, but attention

may be directed to the public textile testing and conditioning house which has been opened at the institute. This house examines textile materials with the object of ascertaining and certifying their true length, weight, condition, and strength; and of carrying out other investigations required by merchants and manufacturers.

THE Northampton Polytechnic Institute, London, E.C., has issued its "Announcements Educational and Social for the Session, 1914–15." The announcements form a volume of 298 pages, and give full particulars of a varied and comprehensive curriculum. The work of the institute is divided into two main sections: an educational section for technological subjects, and a social and recreative section. The educational aim is to provide classes in technological and trade subjects, special attention being directed to the immediate requirements of Clerkenwell, the district in which the polytechnic is situated. Prominent among the day courses is that provided in technical optics. The aim in this department is to provide the thorough theoretical and practical training now required in various branches of the optical industry. It is believed that there is now, and that there will be for some time to come, a considerable demand for well-trained men. In connection with the practical side of this training the department has had the benefit of advice and assistance from prominent members of the optical trade. The full course as at present established extends over two years, and is divided into two sections, for opticians and optical instrument makers respectively. The engineering day college is organised in two departments for civil and mechanical engineering, on one hand, and for electrical engineering on the other. In the former arrangements have been made for the teaching of aeronautical engineering. The course in aeronautical engineering will follow the same plan as the other engineering day courses, that is, the first two years will be devoted to the subjects which form the ground work of all engineering, and the necessary specialisation will take place in the third and fourth years. These are a few examples of the practical character of the instruction given, and a reference only is possible to some of the other courses, which include watch- and clock-making and horological engineering generally, many branches of technical chemistry, and subjects connected with the jewelry, silversmiths', and metal-working trades. Evening classes on an even more comprehensive plan have also been arranged.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, September 7.—M. P. Appell in the chair.—G. **Bigourdan**: Observations of the Delavan comet (1913*f*) made at the Paris Observatory. Positions given for September 2 and 3. The comet was visible to the naked eye in spite of the size of the moon. It appeared to be of the fifth magnitude.—M. **Appell**: A transformation of certain functions deduced from Θ functions of higher degree.—L. **Mangin**: The polymorphism of certain diatoms from the Antarctic. It is shown that the classification of diatoms by the markings or values is faulty, since these show for a given species much less fixity than the structure of the endochrome. The paper is accompanied by numerous illustrations.—M. **Fournier**: The resistance of a fluid to the horizontal translation of a spindle-shaped body, moving in the line of the axis of the figure.—P. **Gaubert**: The faces of solution of dolomite. A study of the relations between the crystalline symmetry and etching figures produced by the action of very dilute nitric or hydrochloric acids.

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Northampton Polytechnic Institute, St. John Street, E.C. Announcements Educational and Social for the Session 1914–15. Pp. 298. (London: Northampton Polytechnic.)

Uganda Protectorate. Annual Report of the Department of Agriculture for the Year ended March 31, 1914. Pp. 67. (Kampala: Uganda Printing and Publishing Co., Ltd.)

Transactions of the Leicester Literary and Philosophical Society, together with the Report of the Council and Annual Reports of the Sections. Vol. xviii. Pp. 103. (Leicester: W. Thornley and Son.) 2*s*. 6*d*.

Poems of the Great War, published on behalf of the Prince of Wales's National Relief Fund. 2nd edition. Pp. 39. (London: Chatto and Windus.) 1*s*. net.

Dove Marine Laboratory, Cullercoats, Northumberland. Report for the Year ending June, 1914. Edited by Prof. A. Meek. Pp. 108. (Newcastle-on-Tyne: Cail and Sons.) 5*s*.

Chemical Technology and Analysis of Oils, Fats, and Waxes. By Dr. J. Lewkowitsch. Fifth edition, entirely re-written and enlarged. Vol. ii., edited by G. H. Warburton. Pp. xiv+944. (London: Macmillan and Co., Ltd.) 25*s*. net.

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Editorial and Publishing Offices:
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.

Advertisements and business letters to be addressed to the Publishers.

Editorial Communications to the Editor.
Telegraphic Address: PHUSIS, LONDON.
Telephone Number: GERRARD 8830.